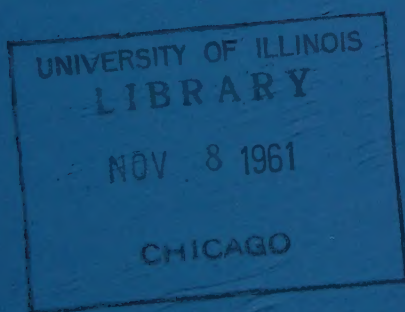


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3-3173 TO 3-3559



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The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

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1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-3196 through 3-3199, 3-3201, 3-3204, 3-3210, 3-3214; Geomorphology 3-3219; Stratigraphy 3-3262, 3-3263; Geohydrology 3-3425, 3-3433, 3-3438, 3-3439; Mineral Deposits 3-3444, 3-3450, 3-3458; Fuels 3-3477, 3-3481; Engineering Geology 3-3547 through 3-3550.

3-3173. Tipper, H. W. GEOLOGY, PRINCE GEORGE, CARIBOO DISTRICT, BRITISH COLUMBIA: Canada, Geol. Survey, Map 49-1960, scale 1:253,440, descriptive notes, 1961.

Preliminary series geological map of about 5,800 sq. mi. around Prince George, E. of Prince Rupert. The oldest rocks of micaceous quartzite, phyllite, and argillite are assigned to the Cariboo group of Cambrian or later age. No fossils were found in them. The Mississippian(?) Slide Mountain group comprises chert and argillite. Basic dikes and sills cut the group. Fossils of the overlying Cache Creek argillite and limestone indicate an Upper Permian age, but the whole period may possibly be represented. Rocks of Cache Creek group are tightly folded and structurally complex. A unit of ultrabasic rocks not in contact with the Mesozoic rocks is mainly confined to areas of Paleozoic rocks. The Upper Triassic(?) and Lower Jurassic(?) strata of argillite, graywacke, and volcanics are followed by Tertiary intrusions which disappear beneath Tertiary and Quaternary sediments. Paleocene(?) to Oligocene volcanic and sedimentary rocks are followed by the Endeavour grays of basaltic and andesitic flows of Miocene and/or later age. Extensive glacial deposits occur. A strong trend of fold axes and faults extends northwesterly. Chrysotile, diatomite, psilomelane, chalcopyrite, and Au are the important minerals.--M. Stewart.

3-3174. Currie, K. L. GEOLOGY, WHISKEY JACK LAKE, MANITOBA: Canada, Geol. Survey, Map 52-1960, scale 1:253,440, descriptive notes, 1961.

Preliminary series geological map of approximately 4,100 sq. mi. N. of Reindeer Lake and E. of Wollaston Lake, on the Saskatchewan-Manitoba border. Bedrock is entirely Precambrian; oldest rock is a biotite-plagioclase schist. Around Misty Lake, garnet-cordierite gneiss occurs as lenses in biotite-plagioclase schist; farther E. it forms a continuous unit. Quartz-poor rocks pass gradationally into quartz-rich gneisses. Feldspathic quartzite forms the last unit of an original sedimentary series where relict bedding is the only sedimentary feature that remains. A complex of basic rocks includes finely laminated amphibolite schists with minor amounts of pyrite and magnetite and sheared hornblende. Interlayered with and cutting this complex, are shattered bodies of metadiorite. Gneissic granitoid rocks underlie 60% of the map-area. E.-trending folds in the meta-sediments cut off NE.-trending folds in the granite. N.80°W. and N.45°E. are the 2 pronounced directions of faulting. No mineral occurrences of economic interest were observed.--M. Stewart.

3-3175. Anderson, Francis D. GEOLOGY, BIG BALD MOUNTAIN, NORTHUMBERLAND COUNTY, NEW BRUNSWICK: Canada, Geol. Survey, Map 41-1960, scale 1:63,360, descriptive notes, 1961, 2 refs.

Preliminary series geological map of about 450 sq. mi. S. of Bathurst and SE. of Edmundston. Rocks are Paleozoic mainly divided on lithology and structure.

A metamorphic assemblage of schists and phyllites probably comprises the oldest rocks in the map-area. A second group of metamorphic rocks consists predominantly of gneiss with minor mica schist and quartzite. The overlying quartzites, slates, and graywackes may, in part, represent a relatively unmetamorphosed equal of the oldest unit. Intermediate volcanic rocks commonly porphyritic and/or porphyroblastic contain lenticular bodies of quartz-feldspar porphyry. Basic volcanics and associated slates and quartzites, commonly graphitic, may be Middle Ordovician in age. Devonian granite to granodiorite and gneissic granite to granodiorite are the 2 granitic rock types of the area. Diorite and diabase sills and dikes are sometimes highly sheared, producing chlorite schists. Red conglomerate may be interpreted as recently limonite-cemented gravel, or as outliers of Pennsylvanian strata. Intense folding and shearing has occurred with numerous faults. Cu, Pb, and Zn sulfides are common.--M. Stewart.

3-3176. Blackadar, Robert G. GEOLOGY, MINGO LAKE, BAFFIN ISLAND, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 43-1960, scale 1:253,440, descriptive notes, 1961.

Preliminary series geological map of about 4,200 sq. mi. at approximately 64°-65°N., 73°-74°W. Two NW.-trending belts of Precambrian quartz-feldspar gneisses surrounding complex schists and gneisses dominate the area. Gradational contacts are found between the feldspar gneiss and a unit of garnet-biotite gneiss. A similar contact can be found between the garnet-biotite gneiss and a migmatitic biotite gneiss. Bands of crystalline limestone interbedded with gneissic rocks roughly parallel the S. contact of the zone of garnetiferous gneisses and related rocks. Associated minerals include diopside, biotite, graphite, phlogopite, sphene, magnetite, and hornblende. Here and there, thin quartzite bands are also associated with the limestone. A pyroxene gneiss unit contains unusually large crystals of dark green pyroxene. Several NW.-trending gabbro dikes cut all consolidated rocks of the area. Magnetite is the most economically important mineral; claims were staked on some of these deposits in 1956 and 1957, but at present there is no activity. Widespread glaciation occurred from the NE.--M. Stewart.

3-3177. Benson, David G., GEOLOGY, HOPEWELL (WEST HALF), NOVA SCOTIA: Canada, Geol. Survey, Map 1-1961, scale 1:63,360, descriptive notes, 1961, 2 refs.

Preliminary series geological map of approximately 200 sq. mi. directly SW. of New Glasgow. The area is covered with varying thicknesses of glacial deposits. The oldest rocks of the area are Ordovician: 1) Goldenville quartzite, 2) Halifax slate, and 3) quartz wacke of the Meguma group. Light gray medium-grained granite of Devonian age appears to have intruded older rocks and caused development of andalusite schists of the Halifax formation. Lower Mississippian sediments of the Horton group comprise siltstones, shales, sandstones, and feldspar arenite. Fossiliferous Windsor limestone and conglomerate probably unconformably overlies the Horton and Meguma groups. The Canso mudstone, siltstone, and shale are bounded by fault zones and are in themselves highly folded. The youngest exposed rocks are sandstone, mudstone, conglomerate, and

carbonaceous shale of the Pictou and/or Cumberland groups. The area has undergone at least 2 periods of deformation: 1) pre-Mississippian folding of the Meguma rocks, 2) gentle folding and faulting in late Pennsylvanian.--M. Stewart.

3-3178. Taylor, F.C. GEOLOGY, ST. MARY BAY, DIGBY, YARMOUTH, AND CHARLOTTE COUNTIES, NOVA SCOTIA AND NEW BRUNSWICK: Canada, Geol. Survey, Map 48-1960, scale 1:253,440, descriptive notes, 1961, 3 refs.

Preliminary series geological map of approximately 3,400 sq. mi. bounded by the 45th parallel, N. of Yarmouth and across from the Bay of Fundy. Precambrian quartzite, argillite, schist, and limestone of the Green Head group are the oldest rocks. On Kent Island, rocks of this group are intruded by red granite. The Precambrian Coldbrook group is divided into both sedimentary rocks (chiefly clastic) and volcanic rocks, (mainly andesites). The Ordovician Meguma group contains slate, minor argillite, and quartzite. These are conformably overlain by quartzite, slate, and volcanics of the White Rock formation. Silurian or Ordovician schistose andesite conformably overlies the uppermost quartzite. Campobello, Deer, and adjacent islands are underlain by an assembly of Silurian sedimentary and volcanic rocks. Several of the small islands between Campobello and Deer Islands are composed of Upper Devonian conglomerate and sandstone. Pleistocene glaciation affected the whole area, ice direction mainly ESE. A N.-trending fault brings Triassic into contact with Precambrian rocks, and another, parallel, fault brings Devonian in contact with Silurian volcanics. Mineral showings include bornite, sphalerite, galena, chalcopryrite, pyrite, and galena.--M. Stewart.

3-3179. Carruthers, C.A. GEOLOGY, NORTH CARIBOU LAKE, ONTARIO: Canada, Geol. Survey, Map 18-1961, scale 1:253,440, descriptive notes, 1961, 2 refs.

Preliminary series geological map of about 6,000 sq. mi. in northwestern Ontario directly E. of Sandy Lake, near the Manitoba border. A large moraine extends NE. to NW. Bedrock is Precambrian, both volcanic and sedimentary. Many flows exhibit pillow structure. Sedimentary rocks exclude [sic] conglomerate, arkose, impure quartzites, graywacke, and shale. The volcanic and sedimentary rocks, associated with banded Fe formation, grade into gneisses and paragneisses. There are also basic to ultrabasic bodies, quartz-rich rocks, porphyritic granites, and leucocratic granites. Minor gabbro and diabase dikes cut all rock types. Jointing is mainly northeasterly and northwesterly, with pronounced linear trends. Au, Cu, and asbestos occur, but no economic prospects have been outlined.--M. Stewart.

3-3180. Donaldson, J.H. GEOLOGY, NORTH SPIRIT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Map 50-1960, scale 1:253,440, descriptive notes, 1961, 6 refs.

Preliminary series geological map of about 6,000 sq. mi. due E. of Lake Winnipeg and approximately 100 mi. E. of the Ontario border. Precambrian rocks underlie the whole area; partial drift cover and glacial striae bear evidence of a single major glaciation from the NE. Eight map units are recognized as follows: 1) Volcanic rocks, mafic intrusions, and metasediments; 2) sediments and derived gneisses and schists,

in part probably older than 1); 3) Fe formation interbedded with 1) and 2); 4) gabbro, diorite of several ages and ultramafic rocks; 5) to 8) granitoid rocks including granodiorite, quartz monzonite, and massive pink leucocratic granite; some of these rocks show distinct foliation. Tight folding occurs along the axes of the sedimentary and volcanic belts. No major faults are recognized, but a wide southeastward trending shear zone from Favourable Lake may indicate a large fault. Au, Ag, galena, sphalerite, pyrite, arsenopyrite, and chalcopryrite have been reported.--P. Harker.

3-3181. Prest, V.K., and J. Hode Keyser. DRIFT-THICKNESS CONTOURS, MONTREAL AREA, QUEBEC: Canada, Geol. Survey, Map 42-1960, scale 1:18,000, 1961.

Preliminary series map showing the results of test boring analyses carried out in the Montreal area since 1951.--B. C. McDonald.

3-3182. Fraser, James Allan. CRACKINGSTONE, SASKATCHEWAN: Canada, Geol. Survey, Map 1095A, scale 1:63,360, 1960.

Geological map of some 300 sq. mi. along the N. shore of Lake Athabasca, immediately S. of Uranium City. The rocks are Precambrian in age. Amphibolite, mylonite, and breccia are of unknown age, but seem to be the oldest rocks in the area. Gneisses of the Archean or Proterozoic Tozin group are derived from sedimentary rocks. Granite gneiss of the same age has an obscure origin, but derivation from a sedimentary rock seems most likely. Sandstone, conglomerate, and arkose of the Proterozoic Athabasca series locally overlie those of Archean or Proterozoic age. Four faults shown on the map follow prominent scarps, valleys, and shorelines. Other marked topographic lineaments in the map-area may also represent faults. Many radioactive mineral occurrences are known in granite-gneiss, in the gneisses of the Tozin group, and a few are in quartzite. The U deposit of Gunnar mines is in a mass of albite-monzonite. The ore consists of disseminated pitchblende replacing albite and filling open spaces in the monzonite. Other metallic minerals present are hematite and traces of pyrite, chalcopryrite, and galena. Nonmetallic introduced minerals include calcite, dolomite, chlorite, and quartz.--M. Stewart.

3-3183. American Geographical Society. NINE GLACIER MAPS, NORTHWESTERN NORTH AMERICA: Its. Spec. Pub. no. 34, 22 p., 15 illus., 10 maps (9 in pocket, scale 1:10,000), table, 1960, refs.

A brochure accompanies maps of 8 glaciers in Alaska and one in the Olympic Mountains, Washington. Seven of the maps are the result of a program organized by the American Geographical Society under the auspices of the U. S. National Committee for the International Geophysical Year, 1957-1958 (Project Y/4.11/194). Field work for 6 of the glaciers - Bear Lake Glacier, Chikuminuk Glacier, Little Jarvis Glacier, Polychrome Glacier, West Gulkana Glacier, and Worthington Glacier - was undertaken during the seasons of 1957 and 1958. Field work was also completed on a glacier in the Skolai Mountains, but owing to unsatisfactory photography no map was constructed. The mapping of Lemon Creek Glacier served as a pilot project. The field work for Blue Glacier and McCall Glacier was not undertaken under the direct

supervision of the Society.

The brochure gives the background of the program, and a description of the various operations, together with a discussion of the results and of the design of the printed maps. The maps were constructed from vertical air photography, and the pamphlet includes sample photographs of the glaciers mapped. The frontispiece is a ground photograph of the headwalls of Polychrome Glacier. In addition, the brochure includes a small-scale map of the general region, which shows the approximate location of each glacier. Large parts of the text are quoted directly from reports prepared by one of the principal participants, Dr. James B. Case. These reports comprised both a Master's thesis and a doctoral dissertation at The Ohio State University.--From foreword.

3-3184. Hoare, Joseph M., and Warren L. Conrad. GEOLOGIC MAP OF THE HAGEMEISTER ISLAND QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-321, scale 1:250,000, lat. 58° - 59° N., long. 160° - 162° 30'W., 1961.

This map covers an area E. of Kuskokwim Bay, and N. of Bristol Bay, in SW. Alaska. The map shows the structure and distribution of the rock units, which consist of clastic rocks interbedded with mafic volcanic rocks, and unconsolidated surficial deposits of Quaternary age. A brief text describes the rock units, structure, and mineral deposits, and gives suggestions for future prospecting.--U.S. Geol. Survey.

3-3185. U.S. Geological Survey. GRAND CANYON NATIONAL PARK, ARIZONA (WEST HALF): scale 1:48,000, contour interval 50 ft., lat. 36° - 36° 25'N., long. 112° 15'- 112° 46'W., 1902-1923, reprinted 1961.

3-3186. Jennings, Charles W., comp. GEOLOGIC MAP OF CALIFORNIA: KINGMAN SHEET: California, Div. Mines, 2 sheets: geol. map, strat. nomenclature, scale 1:250,000, contour interval 200 ft., 5 illus., 1961, 11 refs.

The eighth sheet of the Olaf P. Jenkins edition of the geologic map of California covers the area 35° - 36° N. 114° - 116° W. It indicates in color the geology of the area of southeastern California bounded by Clark County, Nevada, on the E., and extends from the Kingston Range at the NW. corner of the sheet to Devils Playground at the SW. corner.

Twenty-seven state geologic map units appear on the Kingman sheet: 7 Quaternary, 3 undivided Tertiary, 3 Jurassic and Triassic, 1 Mesozoic undifferentiated, 1 each of Permian, Pennsylvanian, Mississippian, undivided Carboniferous, Devonian, Cambrian, undivided Paleozoic, 5 Precambrian, and 1 pre-Cenozoic undifferentiated.

Accompanying the geologic map is an explanatory sheet containing an index map and list of references showing the reports and maps used in compilation of the Kingman sheet, a table of stratigraphic nomenclature and lithologic characteristics, an outline map showing the U.S. Geological Survey topographic maps covering the area, and 3 photographs. The geologic map is also available without the geologic color overprint.--Auth.

3-3187. Dibblee, Thomas W., Jr. GEOLOGIC MAP OF THE BOUQUET RESERVOIR QUADRANGLE, LOS ANGELES COUNTY, CALIFORNIA: U.S. Geol. Sur-

vey, Mineral Inv. Map MF-79, scale 1:62,500, lat. 34° 30'- 34° 45'N., long. 118° 15'- 118° 30'W., 1961.

3-3188. Gwinn, Vinton E. GEOLOGY OF THE DRUMMOND AREA, CENTRAL-WESTERN MONTANA: Montana, Bur. Mines & Geology, Spec. Pub. 21 (Geol. Map 4), 1 sheet with text, scale 1 in. to 1 mi., 1961, 20 refs.

The map covers an area of about 150 sq. mi. in eastern Granite and western Powell counties. The map is printed on a single sheet, 35 x 45 inches, of which 1/4 is occupied by the map and 3/4 by descriptive text. Geologic formations are shown in black and white zip-a-tone patterns.

Sedimentary formations from Mississippian through Tertiary are tabulated, but subdivisions of the Colorado group are described in detail. One new member and 3 new formational names are introduced: Dunkleberg member of the Blackleaf formation, and the Coberly, Jens, and Carter Creek formations - all in the Colorado group of Cretaceous age. The Colorado sequence here is 6 to 7 times thicker than it is in central and eastern Montana, and these sediments contain much volcanic detritus.

The Cretaceous rocks are intruded by dioritic sills and in places overlain by andesitic extrusives and rhyolitic welded tuffs. The diorite sills are involved in the Laramide folding.

A thick sequence of Upper Cretaceous sediments containing much conglomerate and volcanic detritus is described as overlying the Colorado group and is correlated as the Golden Spike facies of the Elkhorn Mountain volcanics.

Economic geology is briefly discussed, and the Forest Rose and Wasa Pb-Zn mines summarized. Under nonmetals, phosphate rock, limestone, diatomaceous earth, and gravel are mentioned.--U.M. Sahinen.

3-3189. Mutch, Thomas A. GEOLOGIC MAP OF THE NORTHEAST FLANK OF THE FLINT CREEK RANGE, WESTERN MONTANA: Montana, Bur. Mines & Geology, Spec. Pub. 22 (Geol. Map 5), 1 sheet with text, scale 1 in. to 1 mi., 1961, 22 refs.

The map covers an area of 184 sq. mi. along the NE. flank of the Flint Creek Range. Geologic formations from Precambrian (Belt) to Recent are shown in black and white zip-a-tone patterns. Map is printed on a single sheet 35 x 45 inches, of which 1/3 is occupied by the map (and sections) and 2/3 by descriptive text.

The text describes the sedimentary and igneous rocks and their structure and metamorphism. Sediments of Cretaceous age and older are intruded by 2 bodies of granitic rock, the Mt. Royal stock (porphyritic granite) and the Mt. Powell batholith (granodiorite). The 2 bodies are closely related in age (early Tertiary), but the Powell batholith is the younger. Other related Late Cretaceous and early Tertiary intrusives (dikes and sills) range in composition from granodiorite to diorite and lamprophyre. Precambrian intrusives are limited to diabase sills.

The late intrusives occupy the southern 2/3 of the area where they are in contact with Paleozoic limestones, quartzites, and shales and with Precambrian quartzites, argillites, and impure limestones of the Belt series. The northern 1/3 of the area is occupied by Mesozoic (mainly Cretaceous) and Tertiary (Oligocene-Miocene) volcanic-rich sediments. Pleistocene glacial material overlies older rocks in the eastern part of the area.

Economic geology is briefly discussed. Lode mining has been unimportant, but Au placers have yielded an estimated \$7 million in Au. Magnetite-rich sandstones (Cretaceous) and phosphate rock are known to occur but are not thought to be of present economic significance. Some occurrences of bentonite are cited.--U.M. Sahinen.

3-3190. Foster, Roy W., and Thomas F. Stipp. PRELIMINARY GEOLOGIC AND RELIEF MAP OF THE PRECAMBRIAN ROCKS OF NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Circ. 57, 37 p., col. geol. map, scale 1:601,920, fig., table, Aug. 1961, 67 refs.

Outcrops of Precambrian rocks are divided into 4 lithologic types on the basis of areal extent: 1) granite and related rocks, 2) metamorphic rocks except granite gneiss (included with granite) and quartzite, 3) quartzite, and 4) intrusive and extrusive rhyolite. Subsurface control used in contouring the Precambrian surface is based on data (listed in the extensive table) from 504 wells that penetrated to Precambrian rocks. Over 200 of these wells are on the central basin platform of eastern Lea County. Control in the remaining part of the state is thus somewhat sparse. The major rock types encountered in drilling are essentially the same as those found on the surface. In order of abundance of occurrence they are: granite, schists, rhyolite, and quartzite. Several wells also bottomed in gabbro, diorite, and metasediments.

In order of increasing age, the rock sequence of the Precambrian in New Mexico can tentatively be established as: 1) intrusive diorite, 2) granite(?), 3) sedimentary rocks and rhyolites, 4) intrusive diorite(?), 5) granite, and 6) metamorphic rocks, including some rhyolites.--Auth.

3-3191. Weir, Gordon W., and others. PRELIMINARY GEOLOGIC MAP AND SECTION OF THE MOUNT PEALE 4 NW QUADRANGLE, SAN JUAN COUNTY, UTAH: U.S. Geol. Survey, Mineral Inv. Map MF-151, scale 1:24,000, lat. 38°07'30"-38°15' N., long. 109°07'30"-109°15'W., 1961.

3-3192. Hansen, Wallace R. GEOLOGIC MAP OF THE DUTCH JOHN MOUNTAIN AND GOSLIN MOUNTAIN QUADRANGLES, UTAH-WYOMING: U.S. Geol. Survey, Misc. Inv. Map I-324, scale 1:24,000, lat. 40°52'30"-41°N., long. 109°15'-109°30'W., 1961.

3-3193. Broedel, Carl H. PRELIMINARY GEOLOGIC MAP SHOWING IRON AND COPPER PROSPECTS IN THE JUNCOS QUADRANGLE, PUERTO RICO: U.S. Geol. Survey, Misc. Inv. Map I-326, scale 1:20,000, lat. 18°07'30"-18°15'N., long. 65°52'30"-66°W., 1961.

3-3194. Bramkamp, R. A., and others. GEOGRAPHIC MAP OF THE WADI AR RIMAH QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map I-206B, scale 1:500,000, lat. 24°-28°N., long. 42°-45°E., 1961.

3-3195. Bramkamp, R. A., and Leon F. Ramirez. GEOLOGIC MAP OF THE CENTRAL PERSIAN GULF QUADRANGLE, KINGDOM OF SAUDI ARABIA: U.S. Geol. Survey, Misc. Inv. Map I-209A, scale 1:500,000, lat. 24°-28°N., long. 51°-54°E., 1961.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geohydrology 3-3437, 3-3438, 3-3439; Engineering Geology 3-3547 through 3-3550.

3-3196. Shea, F. S., and J. D. Wallace. PRELIMINARY REPORT, PORT HAWKESBURY AREA, INVERNESS, RICHMOND COUNTIES, NOVA SCOTIA (WITH GEOLOGICAL AND SOIL MAPS): Nova Scotia, Dept. Mines, Prelim. Rept., 35 p., 11 maps (3 in pocket), 1961, 10 refs. (not seen at AGI).

This study describes an area of approximately 18 sq. mi., situated on Cape Breton Island and covering a portion of southwestern Inverness and Richmond counties, bordering the Strait of Canso. A geological and soil study of this part of Cape Breton was undertaken and previous work reviewed.

The bedrock is composed entirely of sediments ranging in age from lower to upper Carboniferous. The sediments have been deformed by the Appalachian orogeny during which time intense folding took place. These sediments are covered generally by glacial drift in the form of ground moraine till.

Limited studies were made of existing circumstances and the potential regrading surface and subsurface water supply. Investigations were also carried out to assess the occurrence and characteristics of sand and gravel. This also involved the availability of building materials and the condition of bedrock relative to the construction of building foundations, etc.

Included in the study was the possibility of the presence of economic mineralization. The occurrence of limestone and gypsum are too small and of questionable grade to fulfill present day requirements. A very small occurrence of Pb, Zn, and Cu was found in a sandstone horizon at Port Hastings and proved to be of no economic importance.

From these investigations it can be presumed that no metallic mineralization of economic significance exists near surface within the study area.--J.P. Nowlan.

3-3197. Thomson, Robert. PRELIMINARY REPORT ON PARTS OF COLEMAN TOWNSHIP AND GILLIES LIMIT NEAR NEW LAKE, SOUTHEAST OF COBALT, DISTRICT OF TIMISKAMING: Ontario, Dept. Mines, Prelim. Rept. P. R. 1961-2, 68 p., 2 fold. maps, P. 95 and P. 95-A (also available separately), scale 1 in. to 400 ft., Feb. 1961, refs.

The rocks exposed in the area included in Map P. 95 represent a great interval of Precambrian time, from what the writer regards as the oldest Keewatin in the vicinity of Cobalt to Keweenawan. Described are Keewatin rocks, post-Keewatin - pre-Algonian basic intrusives, Algonian granite, post-Algonian - pre-Huronian intrusives, Cobalt series, Nipissing diabase, Keweenawan diabase dikes, and Pleistocene features.

This map sheet area lies a short distance S. of a rich part of the Cobalt camp, and a considerable amount of prospecting and development has been done in search for Ag-Co deposits. To-date only a very minor production of either Ag or Co has been obtained. Prospecting and development has continued from about 1908 to the present. Twenty-one mining properties are described.

Provisional Map P. 95 (showing surface geology) is supplemented by Provisional Map P. 95A, on which are shown the underground workings and also approximate structural contours (at 100-ft. intervals) of the top contact of the Nipissing diabase.--A. C. Sangree.

3-3198. Duquette, Gilles. PRELIMINARY REPORT ON GOULD AREA, WOLFE AND COMPTON ELECTORAL DISTRICTS: Quebec, Dept. Mines, Prelim. Rept. 432, 10p., fold. geol. map (Prelim. Map no. 1344), scale 1:12,000, 1960, ref.

The 22-sq.-mi. area (45°35'-45°40'N, 71°20'-71°25'W.), about 30 mi. NE. of Sherbrooke, was mapped in summer 1959. The bedrock exposures of the area are all Paleozoic. The oldest of them, which antedate the Taconic orogeny, consist of rocks considered as belonging to the Quebec group intruded by 2 types of granite, and the more recent include sedimentary formations of the Lake Aylmer and St. Francis groups, which are posterior to the same Taconic orogeny.

Metamorphosed basic and acidic volcanic rocks of the Quebec group crop out in an irregular area that extends SW. from the northern limit of the map-area. In 1930 Burton used the term Weedon schists to designate them. He has correlated them with the rocks of the Caldwell group, but this correlation is uncertain. The Lake Aylmer and St. Francis groups of Silurian and Devonian rocks overlie the Cambro-Ordovician rocks just mentioned.

Intrusive rocks of granitic composition are found within the Quebec group or between rocks of this group and those of the succeeding Gaspé group.

An important result of the work of the summer 1959 is the discovery that the rocks of the southern two-thirds of the map-area overlie those of the Quebec group with angular unconformity. This is contrary to Cooke's conclusion that the St. Francis rocks are Ordovician. A very small area near the NW. corner of the map-area is underlain by rocks similar to the basal beds of the St. Francis group. These rocks have also been included with the Lake Aylmer limestone which has been considered as belonging to the Upper Silurian or Lower Devonian.

Although the presence of base metals has not yet been reported in the area, pyrite was seen at many places in the Weedon schists. Seven sand and gravel deposits have been exploited.--From p. 1-2, 9-10.

3-3199. McGerrigle, J.I. PRELIMINARY REPORT ON STE-ADELE AREA, TERREBONNE ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 431, 8p., fold. geol. map. (Prelim. Map. no. 1343), scale 1:12,000, 1960, ref.

The 25-sq.-mi. area (45°55'-46°N, 74°05'-74°10'W.), about 50 mi. NW. of Montreal, was mapped in 1959. The rocks of the area are all Precambrian. About 98% of the exposed bedrock belongs to a series that ranges from anorthositic to gabbroic, with the former variety being greatly predominant. Quartzose rocks, considered as belonging to the same series (Morin), are exposed in an irregular band or lens in the extreme SW. corner of the area. In addition, a fairly large but isolated outcrop of gneissic granite was mapped about 1,000 ft. SE. of Ste-Marguerite Station. Some of the more quartzitic rocks in the extreme SW. corner of the area are apparently inclusions of the Grenville series within the Morin rocks. Minor irregular pegmatitic intrusions were noted. A few thin diabase dikes cut the older rock formations. Mineralization is confined to magnetite-ilmenite with some hematite.--From p. 1 and 7.

3-3200. Woodcock, J.R. GEOLOGY OF THE RICHMOND GULF AREA, NEW QUEBEC: Geol. Assoc. Canada, Proc., v. 12, p. 21-39, 3 illus., fold. map, table, Dec. 1960, 10 refs.

Richmond Gulf occupies a depression which projects eastward from the Belcher basin of Hudson Bay. Proterozoic rocks form the E. rim of the Belcher basin and most of the Richmond Gulf shoreline. The Proterozoic strata are divided into 3 units, all separated from one another by angular unconformities and all resting disconformably on an older granitic terrain. From the bottom upward these are: the Pachi group found along the E. and S. sides of Richmond Gulf; the Richmond Gulf formation forming most of the islands and shoreline of Richmond Gulf; and the Nastapoka group found on the coast and the offshore islands along the E. side of the Belcher basin.

The Pachi group consists of a series of arkosic quartzite beds overlain by a sequence of andesitic flows. The Richmond Gulf formation consists of pinkish arkoses. The Nastapoka group consists of the dolomites and quartzites capped by basaltic sills and flows that crop out on the mainland, and the overlying Fe formation and graywacke that crop out on the offshore islands. A gabbroic sill occurs along or close to the unconformity below the Richmond Gulf formation.

Easterly striking faults were formed during the tectonic activity that followed deposition of each group. Block faulting which followed deposition of the Pachi group, caused the general depression of the Richmond Gulf area. Relative uplift of smaller blocks within this depression is indicated by the granitic ridges that are prevalent E. of the Gulf. Renewed faulting, but with smaller vertical displacements, followed deposition of the Richmond Gulf formation. Deposition of the Nastapoka group was followed by uplift, tilting to the SW., gentle folding, and some vertical faulting with negligible vertical displacement. Isostatic adjustment following removal of the glacial ice is at present uplifting the region.

The 3 arcuate faults parallel to the edge of the Belcher basin that appear on tectonic maps of the region, and the general structure of the region are discussed briefly.--Auth.

3-3201. Irwin, William P. GEOLOGIC RECONNAISSANCE OF THE NORTHERN COAST RANGES AND KLAMATH MOUNTAINS, CALIFORNIA, WITH A SUMMARY OF THE MINERAL RESOURCES: California, Div. Mines, Bull. 179, 80 p., 15 illus., 16 figs., col. geol. map (in pocket), scale 1:500,000, 1960, 134 refs.

This report describes the geology of northwestern California, an area of approximately 19,000 sq. mi. that includes most of the northern Coast Ranges and the Klamath Mountains geologic provinces in addition to the western part of the Sacramento Valley province. The geologic provinces of California differ markedly from the standpoint of topography, geologic history, and mineral deposits. The Klamath Mountains province is an area of rugged mountains, with many peaks reaching an altitude of more than 6,000 ft. and a few nearly 9,000 ft. Accordant ridges are conspicuous features, most commonly below 6,000 ft., and evidence of former glaciation is widespread in the higher parts of the mountains. The Klamath Mountains province is drained chiefly by the Klamath River and its tributaries, and by the Smith River. The drainage in general is from E. to W., and cuts across the lithic and structural grain of the province. In contrast, the northern Coast Ranges are lower in general altitude, and only along the main divide between the Coast Ranges and the Sacramento Valley drainage do a few peaks reach as high as 6,000 ft. and show evidence of former glaciation. The principal

rivers of the northern Coast Ranges are the Eel, Mad, Van Duzen, and Russian. The general course of the drainage is parallel to the structural and lithic grain of the province and, with exception of the Russian River, is northwestward. The Russian River flows southeastward for much of its length. In the northern Coast Ranges, as in the Klamath Mountains, accordant ridges are abundant, but are generally at lower altitudes.

The chief basis for defining the 2 provinces lies in a natural grouping of the principal rock units of each province with regard to intrusion by granitic rocks. The principal rock units of the Klamath Mountains range from early Paleozoic to middle Late Jurassic in age and are intruded by granitic rocks that range from the hornblende diorite to true granite. In the northern Coast Ranges the principal rocks range from late Late Jurassic to Cretaceous in age, and there is little evidence that they have been intruded by granitic rocks. The principal rocks of both provinces, however, are intruded by abundant mafic and ultramafic rocks.

The Klamath Mountains comprise 4 concentric, arcuate belts that are concave to the E. From E. to W. the belts are 1) the eastern Paleozoic belt, 2) the central metamorphic belt, 3) the western Paleozoic and Triassic belt, and 4) the western Jurassic belt. The formations of the eastern belt are well known, with the exception of the oldest unit which includes Silurian and perhaps even Ordovician rocks. The other formations are chiefly the Copley greenstone of Devonian age, the Kennett formation of later Devonian age, and the Bragdon formation of Mississippian age. The metamorphic rocks of the central belt are mainly quartz-mica and hornblende schists of the Abrams and Salmon formations and generally have been considered the oldest rocks of northwestern California. The western Paleozoic and Triassic belt includes mildly metamorphosed shales, sandstones, cherts, greenstones, and limestones. They have been studied little, and have been referred to variously as the Lower Slate and Blue Chert series, the southwestern Devonian and Carboniferous belts, the Chancelulla formation, and the Grayback formation. The extension of the belt into southwestern Oregon includes the Applegate group. The western Jurassic belt includes the Galice formation of middle Late Jurassic age, and mica schists and greenschist. The schists include the Weitchpec and Kerr Ranch schists, and the schists of South Fork Mountain. These schists generally have been correlated with the Abrams mica schist of the central metamorphic belt, but herein are described as metamorphic equivalents of the Galice formation.

The northern Coast Ranges are chiefly graywackes and shales that range in age from late Late Jurassic to Late Cretaceous. Along a NW.-trending central belt, the graywacke generally contains little or no K feldspar and is interbedded at many places with cherts and greenstones. This assemblage of graywacke, chert, and greenstone is referred to as the Franciscan formation, as it is similar to the Franciscan formation of the type area on the San Francisco Peninsula. Along the northern part of the E. side of the central belt, the Franciscan formation is faulted against schist of the western Jurassic belt of the Klamath Mountains province. Along the southern part it is bordered by a wedge of mildly metamorphosed rocks, at least some of which are equivalents of the Franciscan of the central belt. The mildly metamorphosed rocks are separated from the Sacramento Valley sequence by a N.-trending band of serpentine. A coastal belt of graywacke and shale lies

W. of the central belt of the Franciscan formation. These rocks are not, as is generally thought, part of the Franciscan formation, as the graywackes generally contain appreciable quantities of K feldspar, and as chert and greenstones are rare.

The Sacramento Valley sequence is an orderly pile of graywacke, shale, and conglomerate that has been subdivided into the Knoxville formation of late Late Jurassic (middle Tithonian) age, the Shasta series of Early Cretaceous age, and Upper Cretaceous rocks. The strata of the Sacramento Valley sequence contain appreciable quantities of K feldspar, bulkwise, and the average content increases from the oldest to the youngest rocks. In general the strata dip eastward, away from the Coast Ranges, and form conspicuous strike ridges that trend northward along the W. side of the Sacramento Valley. The age of the Franciscan with respect to the Sacramento Valley sequence is not clearly known. On a paleontologic basis, the Franciscan seems to range from late to Late Jurassic to Late Cretaceous in age, and thus to be an equivalent of the Sacramento Valley sequence. On other evidence, however, some of the Franciscan appears to be Late Jurassic in age and older than the oldest strata of the Sacramento Valley sequence.

Marine sedimentary rocks that probably range in age from latest Cretaceous to early Tertiary occur in the northern Coast Ranges. These include the Yager formation near Cape Mendocino, unnamed beds near Covelo, and the Gualala series along the coast southeastward from Pt. Arena. The Gualala series lies W. of the San Andreas fault, forming a northwesterly extension of the fault block bounded by the San Andreas and Nacimiento faults.

Sedimentary rocks of Tertiary age occur in both the northern Coast Ranges and Klamath Mountains, and cover an extensive area underlain by the Jurassic and Cretaceous strata along the W. side of the Sacramento Valley. They range in age from Eocene through Pliocene. In the Coast Ranges they are chiefly marine in origin, whereas in the Klamath Mountains and Sacramento Valley they are mainly continental. Volcanic rocks of Tertiary age occur sparsely near Clear Lake in the report area, but they cover large areas southward in the Coast Ranges and eastward in the Cascade Range.

Rocks of Quaternary age cover only a small percent of the area of northwestern California. They include valley fill, coastal and river terrace deposits, landslide debris, glacial deposits, and beach and dune sands. Volcanic rocks of Quaternary age are abundant in the report area only at Clear Lake in the northern Coast Ranges.

The structure of northwestern California is highly complex and poorly known. In both provinces the strata most commonly dip eastward. In the northern Coast Ranges the principal structures appear to be NW.-trending strike-slip faults of the San Andreas system, and subparallel folds. The boundary between the Coast Ranges and western Klamath Mountains is a high-angle reverse fault that for much of its length is nearly parallel to the faults of the San Andreas system. The southern boundary of the Klamath Mountains province is a transverse fault that is aligned with major transverse faults in the Sacramento Valley and the Coast Ranges and may be related tectonically to the Gorda submarine escarpment. The arcuate arrangement of lithic belts in the Klamath Mountains province is interpreted as resulting from forces from the E., and the boundaries between the lithic belts are thought to be chiefly reverse faults that dip eastward.

Mineral commodities having a total value of approximately \$150 million have been produced from

the area since the middle 1800's. During the early days the production was chiefly metallic minerals, especially Au, but during recent years the production of nonmetallic mineral commodities such as sand, gravel, crushed rock, and natural gas has exceeded the value of the metallic minerals. Large quantities of Au have been produced from both placer and lode deposits, essentially restricted to the Klamath Mountains province. Chromite has been mined from areas of ultramafic rock, and about two-thirds of the production has been from the Klamath Mountains. Cu occurs in complex sulfide ores, and all but one of the deposits with a record of significant production are in the Klamath Mountains. Important quantities of quicksilver have been produced from several deposits in the Coast Ranges and from one deposit in the Klamath Mountains. Many deposits of Mn occur in both provinces, but most of the small production has come from deposits in chert members of the Franciscan formation in the northern Coast Ranges. The production of gas and oil from strata of Tertiary age is becoming of increasing importance in the northern Coast Ranges in western Humboldt County.--Auth.

3-3202. Society of Economic Paleontologists and Mineralogists, Pacific Section. GUIDEBOOK, 1961 SPRING FIELD TRIP, MAY 12-13, 1961. GEOLOGY AND PALEONTOLOGY OF THE SOUTHERN BORDER OF THE SAN JOAQUIN VALLEY, KERN COUNTY, CALIFORNIA: 42 p., 3 figs., 2 geol. maps (in pocket), 3 secs. (in pocket), 1961, 14 refs.

This guidebook was prepared for the joint Spring field trip of the Pacific Sections, Society of Economic Paleontologists and Mineralogists, Society of Economic Geologists, and American Association of Petroleum Geologists, and the San Joaquin Geological Society. Contents consist of an abstract of a paper on the geologic structure of the San Emigdio Mountains, Kern County, by T. W. Dibblee, Jr.; Road log for the San Emigdio field trip; abstracts of papers on oil fields; geophysical abstracts; and paleontology abstracts.--A. C. Sangre.

3-3203. Dolan, Edward M., and Glenn T. Allen, Jr. AN INVESTIGATION OF DARBY AND HORNSBY SPRINGS SITES, ALACHUA COUNTY, FLORIDA: Florida, Geol. Survey, Spec. Pub. 7, 124 p., 10 figs., 16 pls., table, 1961.

Hornsby and Darby springs are located in sec. 27, T.7S., R.17E., Alachua County. Physiographically, this area is a part of the northern zone of the 3 trans-peninsular zones (northern, central and southern) in which the piezometric surface of the artesian water is below the ground surface, thus giving rise to features of dry highland or dead karst. Darby and Hornsby springs are 2 of the several large artesian springs that are present along the valleys. These springs emerge from a large underground cavern about 85 ft. below the surface of the water. The area is riddled with solution pipes and potholes which are in the Crystal River formation.

Seventeen well developed solution pipes were excavated at Hornsby Springs site. These vertical solution pipes are 8 to 40 in. in diameter and are lined by weathered, white to gray, sandy shell marl. This marl merged upward with a brown, organic, sandy fresh-water shell marl. The center of the solution pipe contained brown, fine- to medium-grained quartz sand in a noncalcareous matrix of organic clay. This brown core contained remains of Mammut americanum, Equus sp., opossum, turtle, and other small

vertebrate fossils and worked lithic material which are described in this report.

Carbon-14 date of 9,880±270 years was determined for the fresh-water shell marl that covered the solution pipe to a depth of 1 ft. at one of the sites at Hornsby Springs. This dating established the contemporaneity of the Pleistocene vertebrate fossil remains and lithic artifacts, and the existence of a Paleo-Indian-Preceramic-Early Archaic sequence in Florida with a beginning of 9,880±270 years.--H. S. Puri.

3-3204. Brown, C. Ervin, and Jesse W. Whitlow. GEOLOGY OF THE DUBUQUE SOUTH QUADRANGLE, IOWA-ILLINOIS: U.S. Geol. Survey, Bull. 1123-A, 93 p., 18 figs., 7 pls. (in pocket) incl. geol. map, scale 1:24,000, table, 1960, 57 refs.

The Dubuque South quadrangle is an area of 52 sq. mi. in Iowa and 3 sq. mi. in Illinois, in the southwestern part of the Wisconsin-Illinois-Iowa Zn-Pb district. Topography generally is in a mature stage of erosion; relief is about 590 ft. The Mississippi River and a cuesta of Silurian rocks are prominent features.

Rocks exposed in the quadrangle are from the cherty unit of the Galena dolomite, Middle Ordovician age, to the Hopkinton dolomite, Middle Silurian age. The divisions are in ascending order: the Galena dolomite is divided into a lower cherty unit and an upper noncherty unit; the Maquoketa shale, Late Ordovician age, is divided into a brown shaly unit, Brainard and Neda members. An erosional unconformity that has at least 135 ft. of relief is between the Maquoketa shale and the Edgewood dolomite, Early Silurian age. The Edgewood is divided into Tete des Morts and Mosalem members. The Kankakee formation, Early Silurian age, is cherty dolomite that is as much as 50% white bedded chert. The Hopkinton dolomite is coralline and cherty dolomite that is as much as 60% chert.

A regional southwestward dip of 18 ft. per mi. is in the quadrangle, and small folds are on this dip.

Galena was mined in the quadrangle from 1690 to 1910. Zn ores were mined from the late 1870's to 1910. Although large pitch-and-flat deposits may be present, they have not been found because generally mining and prospecting were not deep enough.--J. W. Whitlow.

3-3205. Gerhard, Roberta, and Grace Muilenburg. GEOLOGIC FIELD CONFERENCE IN NORTHEASTERN KANSAS: 28p., illus., maps, secs., [Lawrence, Kansas], State Geological Survey, University of Kansas, 1961(not seen at AGI).

The geology, landscape, and mineral resources of the Kansas River valley area between Lawrence and Kansas City are presented generally and in detail for 11 localities. An abbreviated road log for a 115-mi. round trip from Lawrence to Wyandotte County Park is given, and illustrations include a geologic map, a generalized column of outcropping rocks of the area, detailed geologic sections, location maps, and sketches.

The guidebook is written in semitechnical style and is suitable for use by professional geologists and by laymen having some geologic background. It is a revision of several previously issued mimeographed guidebooks, prepared specifically for use on field conferences sponsored by the Kansas Geological Survey for high school science students attending the annual Science and Mathematics Camp at The University of Kansas.--G. Muilenburg.

3-3206. Johns, Willis M. PROGRESS REPORT ON GEOLOGIC INVESTIGATIONS IN THE KOOTENAI-FLATHEAD AREA, NORTHWEST MONTANA: NO. 3, NORTHERN LINCOLN COUNTY: Montana, Bur. Mines & Geology, Bull. 23, 57p., 10figs., 6 maps, 1961, 26 refs.

The report covers work completed in the Ural and Yaak River quadrangles during 1960 field season. The map area embraces 1,220 sq. mi., amounting to nearly 34 townships in the NW. corner of the state. The Kootenai River is an arbitrary boundary between the Purcell Range W. and the Selish Range E. A large part of the Ural and all the N. Yaak River quadrangle lies within the Purcell Range.

The area mapped, similar in lithology and structure to other quadrangles in Lincoln County, is underlain by Precambrian Belt rocks subdivided into 4 major conformable groups. From oldest to youngest, the Prichard argillite of the Pre-Ravalli group, Ravalli group, Piegan group, and the Missoula group.

Precambrian rocks were folded during the Laramide orogeny into broad and moderate N. and NW. trending folds and subsequently faulted by N. to NW., NE., and E.-W. faults. The older N. to NW. faults parallel and often follow fold axes.

Igneous rocks include Precambrian metadiorite sills intrusive into Prichard, Ravalli, and uppermost Piegan strata; the Purcell basalt, composed of at least 2 flows extruded into shallow water; and late Mesozoic or early Cenozoic metadiorite dike and syenite stock intrusive into Prichard sediments.

The lowest strata of the Prichard argillite were observed on an anticline W. of Yaak River. Ravalli and Piegan groups thin to the N., whereas the Ravalli quartzite becomes more blue-toned and argillaceous in the eastern part of the Ural quadrangle. The basal Missoula unit, mapped in the Thompson Lakes and S. Yaak River quadrangles as the Striped Peak formation, was not recognized in the Ural and N. Yaak River quadrangles.

Au-quartz, Pb-Ag, Cu, and barite veins occur within the quadrangles as lode deposits. At one mine, the Independence property in the Whitefish Range, a Cu vein is associated with the Purcell basalt. Two placers on the Kootenai River S. of Rexford, Montana, were active during the summer of 1960.--Auth.

3-3207. Tulsa Geological Society and Fort Smith Geological Society. GUIDEBOOK, ARKOMA BASIN AND NORTH-CENTRAL OUACHITA MOUNTAINS OF OKLAHOMA. FIELD CONFERENCE, APRIL 14-15, 1961: 78p., illus., maps, secs., [Tulsa, Oklahoma?] 1961, refs.

This joint field conference visited both geologic provinces, the Arkoma basin and the Ouachita Mountains, that have had major gas discoveries during 1959-1961. The emphasis of the trip is upon the petroleum geology of the region. The Arkoma basin receives more attention than the Ouachitas on this trip. Field conferences have long bypassed the basin, and the recent deep gas discoveries in the basin are many times larger than those in the Ouachitas. It is not the intent to isolate one province from the other, for the 2 are contiguous, and there is much to be learned about one from the study of the other.--From introd.

Contents are as follows:

Road Log - Fort Smith to Kiamichi Mountain via Poteau, Return to Fort Smith via Hartford.
Road Log - Fort Smith to Wilburton via Bokoshe, McCurtain and Kinta, Return to Fort Smith via Red

Oak and Poteau.

Road Log - Tulsa to Fort Smith via U.S. Highway 64.
Road Log - Tulsa to Muskogee via Wagoner.

A Brief History of Fort Smith, by Otis O. Fox.

General Geology of the Red Oak Gas Area, Latimer and LeFlore Counties, Oklahoma, by Kenneth M. McClain and Roger N. Planalp.

Cartersville Gas Field, by J. A. Lahoud.

The Geology of the Kinta Gas District, by John Wonicik.

Map of Gas Pools in and Near Field Trip Area.

Significant Fields and Prolific Recent Discoveries in and Near Field Trip Area, by W. A. Rose.

Structural Framework of the Arkoma Basin, by W. E. Diggs.

Surface Stratigraphy of the Hartshorne Formation, LeFlore, Latimer and Pittsburg Counties, Oklahoma, by Gary McDaniel.

Carboniferous Stratigraphy of the Ouachita Mountains, by Richard B. Laudon.

Arkoma Basin, a Middle Pennsylvanian Geosyncline, by Carl C. Branson.

3-3208. Bell, Robert Joe. PRE-PENNSYLVANIAN SUBSURFACE GEOLOGY OF THE EAST LINDSAY AREA, GARVIN COUNTY, OKLAHOMA: Shale Shaker, v. 11, no. 7, p. 2-16, 5 figs., 6 pls., March 1961, 16 refs.

The East Lindsay area is located in the northwest-ern portion of Garvin County, Oklahoma, and includes Township 4 N., Ranges 3 and 4 W.

The Pre-Pennsylvanian topography of the area was not a peneplain when the seas invaded the land during Des Moinesian time, but instead consisted of structural highs and lows with several fault line scarps present.

The Hunton limestone produces primarily from fracture porosity in the area rather than from porosity caused by solution. The top of the Fernvale-Viola horizon reflects structural conditions similar to those of the underlying Simpson group and the Arbuckle limestone. The major faulting here is normal "down to the basin" faulting striking northwestward.

Two major structural highs are present in the area that have not been explored. One is in the center of T4N-R3W and the other is in the Erin Springs area.--C. E. Branham.

3-3209. Harvey, Ralph Leon. SUBSURFACE GEOLOGY OF A PORTION OF SOUTHERN HUGHES COUNTY, OKLAHOMA: Shale Shaker, v. 11, no. 5, p. 2-16, 18, 6 maps, 2 secs., 2 pls., 2 tables, Jan. 1961, 42 refs.

The area in this report lies in both the NE. Oklahoma platform and the McAlester basin tectonic provinces. A comprehensive discussion of the stratigraphy of the area is included. A structure map on the Hartshorne sandstone indicates a N.-S. striking fault through the area with a throw of 167 to 497 ft. A prominent anticline extends S. through the center of the area on which local closures are covered with production. A structure map of the Wapanucka is similar except the dip is steeper and the closures slightly more prominent. There is no significant difference between a map of the Viola and the Wapanucka.

Nearly all the faulting observed either occurred or was rejuvenated near the end of Savanna time as a result of an uplift centered in the Arbuckle Mountains.

A resume of the producing fields in the area is included with cumulative production, type of trap, and

future potentials included. Each field's history, development, and present status is described. The future possibilities of oil and gas development is discussed with attention placed on the various sand members in the Pennsylvanian and their productive importance.--C. E. Branham.

3-3210. Overstreet, William C., and Henry Bell, 3d. GEOLOGIC RELATIONS INFERRED FROM THE PROVISIONAL GEOLOGIC MAP OF THE CRYSTAL-LINE ROCKS OF SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 5, no. 3, p. 39-41, map, May-June 1961, 6 refs.; reprinted from: U.S. Geol. Survey, Prof. Paper 400-B, p. B197-B199, 1960.

Original paper was abstracted as GeoScience Abstracts 2-3189.

3-3211. Shufflebarger, Thomas E., Jr. NOTES ON RELATIONSHIPS OF PIEDMONT METASEDIMENTARY ROCKS, WITH EMPHASIS ON THE POOR MOUNTAIN-CHAUGA RIVER AREA, OCONEE COUNTY, S. C.: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 5, no. 3, p. 31-38, 2 figs., table, May-June 1961, 16 refs.

It is suggested that the metamorphic rocks which spanned the interval from the Carolina gneiss to the Arvonian slate-Volcanic series, together with their age-equivalents, may have formed a continuous sequence throughout the Piedmont.

The marble and dolomitic marble that crop out in the vicinity of Poor Mountain are thought to be part of the Brevard belt and may correlate with marble of the Evinston group of Virginia. Hence, the "Poor Mountain marble" as well as the "Chauga River dolomitic marble" may be early Paleozoic in age.

The principal structures of the Poor Mountain area appear to be shear folds in the upper plate of an overthrust. It is suggested that Poor Mountain is an allochthonous mass of metasediments, possibly folded prior to faulting. This overthrust has apparently displaced the younger, marble-bearing sequence with respect to the older over-ridden gneiss.--Auth.

3-3212. Society of Economic Paleontologists and Mineralogists, Gulf Coast Section. FIELD TRIP GUIDEBOOK. MIDDLE EOCENE OF HOUSTON CO., TEXAS: 45 p., 11 figs. incl. 2 maps, secs., [Houston, Texas], May 1961, 31 refs.

Stratigraphy and environment of deposition of the Claiborne (middle Eocene) of central eastern Texas were studied on a one-day field trip to Houston County. Type localities of the Crockett (Cook Mountain) formation, Hurricane lentil (lower Crockett), and Weches formation were visited.

Lithology, sedimentary textures, and fossils indicate that this area was at or near shoreline during middle Eocene time, with fluctuations from fluvial to open marine conditions. Formations and members are distinguished by changes in grain size and fossil content caused by these transgressions and regres-

sions.

The lowermost Claiborne formation, the Reklaw, is present in the subsurface only as brackish to very shallow marine fossiliferous sand and shale with some glauconite. Queen City dark gray, lignitic sands and shales were deposited in a nonmarine environment. Overlying Weches fossiliferous green-sands indicate deposition in marine waters as much as 50 ft. deep. Regression of the sea during Sparta time resulted in deposition of clean sands at the base, grading up to lignitic shales and sands at the top which closely resemble the upper Queen City. The Crockett (Cook Mountain) formation is represented by lower marine marls and shales (Wheelock and Landrum member equivalent), middle deltaic to nonmarine sands (Spiller equivalent), and upper marine shales (Mt. Tabor equivalent). Overlying the Crockett are nonmarine, massive sands of the uppermost Claiborne Yegua (Cockfield) formation.--R. P. Zingula.

The guidebook is divided into 4 parts: 1) road log with description of outcrops; 2) depositional history of the Gulf Coast middle Eocene formations; 3) notes on the stratigraphy and paleontology of some of the middle Eocene formations in Houston County; 4) annotated bibliography of the more important publications on the middle Eocene of eastern Texas and adjacent areas.

3-3213. Weaver, John D. INSTITUTE OF CARIBBEAN STUDIES FIELD EXCURSION TO ISLA MONA (5TH.-7TH. NOVEMBER, 1960): Caribbean Jour. Sci., v. 1, no. 1, p. 30-32, Feb. 1961, ref.

One purpose of the field trip was to investigate the necessity for geologic studies on Mona Island, W. of Puerto Rico. Two formations have been recognized, the lithologically similar Miocene Isla Mona limestone and the Pleistocene(?) Lirio limestone. The 2 units are reportedly unconformable. The line of the unconformity is marked by a series of coastal caves, but its trace westward from its type exposure at Punta Este is obscure. The unconformity line may actually represent an old shoreline. The plateau surface of the island may also represent a marine erosion surface. Few fossils were found, so that correlation work may be difficult. Accurate surveys of the coastal cave and surface plateau levels are needed to solve the problems of the possible unconformity and of the marine erosion levels.--A. A. Meyerhoff.

3-3214. Salisbury, John W. AN INTRODUCTION TO THE MOON: 30 p., 7 figs., fold. mosaic, scale 1:10,000,000, Bedford, Massachusetts, U.S. Air Force, Cambridge Research Center, Geophysics Research Directorate, July 1960, 6 refs.

Present knowledge and theories concerning the origin of the moon and lunar surface structures are summarized in layman's language for use primarily by schools and teachers. Topics include: origin of the moon, lunar interior and surface, and lunar experiments (satellite, hard- and soft-landing lunar probes, manned landing).--M. Russell.

See also: Geologic Maps 3-3181, 3-3183; Paleontology 3-3273; Mineralogy 3-3390; Sedimentary Petrology 3-3405, Engineering Geology 3-3534.

3-3215. Nairn, A. E. M. **DESCRIPTIVE PALAEO-CLIMATOLOGY:** 380 p., illus., maps, graphs, tables, NEW YORK, Interscience Publishers, 1961, refs.

It was only natural, when geology revealed the vast expanse of time and unearthed bizarre animal forms and a vastly different geography, to speculate on the climatic conditions of those ages. The harnessing of this intellectual curiosity to detailed observation and investigation has produced the sciences of paleogeography and paleoclimatology.

The climates of the past, because of their great general interest, have suffered more than most sciences from preconceived ideas, and the tendency to be used as an adjunct to other work. The biggest steps forward were the recognition that current climate cannot be regarded as "normal," and the need to consider geographical position as a possible variable. The latter possibility is the centre of the geological controversy over continental drift. It is therefore difficult to strike a balance between the amount to which climatic variation can be attributed to latitudinal variation, and to actual climatic fluctuation due primarily to variations in the earth's heat budget.

In this volume, the pooled knowledge of many scientists has gone into the probing of the generally accepted evidence of climate, with results which show the need for caution. These follow a series of outline essays on the climatic histories of large areas. The paucity of information from many parts of the world as well as the size of the areas involved precludes any more detailed examination and prevents any rigid conclusions being drawn.--From auth. pref.

The 14 papers in this volume are listed below.

- The Scope of Palaeoclimatology, by A. E. M. Nairn.
- Fundamentals of Climate, by H. H. Lamb.
- The Palaeoclimatological Significance of Desert Sandstone, by N. D. Opdyke.
- Palaeoclimatic Significance of Evaporites, by Robert Green.
- Climatic Significance of Red Beds, by F. B. Van Houten.
- Geological Evidence of Cold Climate, by R. F. Flint.
- The Application of Geophysics to Palaeoclimatology, by A. E. M. Nairn and N. Thorley.
- Palaeozoological Evidence of Climate. (1) Vertebrates, by A. S. Romer.
- Palaeozoological Evidence of Climate. (2) Invertebrates, by G. Y. Craig.
- Palaeobotanical Evidence of Climate, by R. Kräusel.
- The Climatic History of Europe and North America, by M. Schwarzbach.
- The Climatic History of the Far East, by Teiichi Kobayashi and Tokio Shikama.
- The Palaeoclimatology of Gondwanaland during the Palaeozoic and Mesozoic Eras, by L. C. King.
- The Climates of Gondwanaland in Kainozoic Times, by E. D. Gill.

3-3216. Wright, H. E., Jr. **LATE PLEISTOCENE CLIMATE OF EUROPE: A REVIEW:** Geol. Soc. America, Bull., v. 72, no. 6, p. 933-983, 9 figs., 3 tables, June 1961, 160 refs.; abs. in French, Spanish, German, and Russian.

The Pleistocene periglacial environment of Europe is believed to have been marked by intensive frost action and wind action and by the spread of arctic and subarctic plants and animals S. to the Alps. The frost action is recorded by ice-wedge casts, involutions, soli-

fluction deposits, block fields, and related deposits, some of which may record permafrost. The occurrence of extensive sand dunes and loess deposits may be related to the distribution of glaciofluvial plains, strong winds, and the absence of forest cover. The occurrence of a tundra zone in the basal levels of late-glacial pollen sequences in central Europe indicates a frigid climate, and molluscan and mammalian faunas provide similar information.

Poser and Büdel have separately attempted to represent the Pleistocene climatic-vegetational zones of Europe on maps. Poser located the southern limit of permafrost according to the distribution of ice-wedge casts and involutions, and the northern limit of forest from pollen-analytical evidence summarized by Firbas. These 2 map lines were then used to help delineate several vegetational-climatic provinces. An additional study on the late-glacial sand dunes led to the presentation of a map of mean summer air pressure for Europe.

Büdel located the Pleistocene frost limit on the basis of its presumed relation to the 1,000-m. snow line, which is identifiable in the mountains of central Europe. His representation differs from Poser's chiefly for Hungary and France, where there is a dearth of pollen studies from which vegetational relations can be inferred. Büdel distinguishes several vegetational zones throughout Europe on the basis of loess distribution and also from pollen diagrams where available. Büdel believes that the ice sheet had only a minor effect on the climatic zonation of Europe during the Pleistocene.

Although exception is taken to many details of the criteria used by Poser and Büdel for vegetational zonation, the maps are considered useful as a basis for discussion of Pleistocene atmospheric circulation patterns.

The sequence of climatic changes for the last cold period is inferred largely from the stratigraphy of periglacial loesses and intercalated soils, and from their correlation with the Alpine glacial sequence. The controversy concerning the classification of the Würm period as single (following Penck) or as multiple (following Soergel) is reviewed; the validity of the Götting interstadial is questioned on the basis of recent field studies and radiocarbon dates in Austria and adjacent areas.

The reduction of mean annual temperature during the late Pleistocene, as inferred from the snow-line depression in the mountains, amounted to 5°-8°C. under the general assumption of a 0.5°-0.7°C./100 m. vertical temperature gradient (lapse rate) in the atmosphere. Calculations based on the occurrence of frost features and fossil plants in lowlands, however, suggest a temperature depression of 10°-12°C. The discrepancy may result from different lapse rates over mountains and over lowlands, according to Mortensen. Studies of modern lapse rates in arctic, subarctic and subtropical regions are reviewed in order to evaluate this hypothesis.

Maps of mean atmospheric pressure and circulation patterns are commonly based on extrapolation from those modern patterns that are related to snowy winters, cool summers, and other conditions favorable to glaciation, on the assumption that the Pleistocene climate was marked primarily by a different frequency of certain air-mass movements and related storm tracks compared to today. Possible causes for circulation changes are still highly speculative, although much recent interest is centered on variations in solar radiation such as are exhibited in sunspots.--Auth.

3-3217. Bowen, Robert. PALEOTEMPERATURE ANALYSES OF BELEMNOIDEA AND JURASSIC PALEOCLIMATOLOGY: Jour. Geology, v. 69, no. 3, p. 309-320, 2 figs., 16 tables, May 1961, 15 refs.

Almost 100 specimens of Jurassic Belemnoida were analyzed and their paleotemperature record compiled from mass-spectrometric measurements. They were of world-wide origin, and their δ -values in parts per mil (‰) are averages of whole specimens and are related to the standard PDB-1. Of this assemblage, 14 specimens were analyzed for δ -variation during growth, i. e., data were derived from examination of successive increments of powdered carbonate from the rostra. These results are also related to PDB-1. The information so obtained is compared with that given by other fields of investigation. It is demonstrated that in the Jurassic the earth has larger tropical and semitropical belts than at present, with an equatorial region running through the USA and Europe (which could have been closer together than they are now). The paleotemperatures confirm the Tethyan and Arctic transgressions in the latter area. The positions of the poles remain uncertain, but the N. pole probably occupied a position somewhere in E. Asia. India lay in the temperate zone much farther from the equator than at present. Alaska and New Guinea were both cool-water areas in the Jurassic. It may be inferred that the poles were much warmer than at present, since the belemnoid evidence (obtained from nektonic animals that ranged over most of the seas) shows a temperature range much smaller than that existing now, around 20°C. as compared with about 60°C. today. Well-marked seasonal variations are shown by the belemnoids, but these usually cover small ranges of the order of 20-50°C. Thus, although the Jurassic was an extremely equable period, seasons did exist.--Auth.

3-3218. Sharp, Robert P. GLACIERS: 78 p., 23 figs., 15 pls., Eugene, Oregon, University of Oregon Press, 1960, 15 refs.

This pamphlet is a Condon Lecture publication, established by the Oregon State System of Higher Education. It presents a description of some basic facets as background for an understanding of certain facets of modern glaciological research. It is not an elementary handbook, but it does attempt to present material in an informal style with a minimum of technical jargon. Emphasis is purposely placed upon matters and subjects of personal study. Many phenomena, as for example the nature, magnitude, and cause of glacier fluctuations which attract great popular interest, are largely untreated.

The Blue, Saskatchewan, and Malaspina-Seward glaciers are used as examples of the various features and phenomena discussed. The Malaspina is a piedmont glacier. It is a sheet covering about 850 sq. mi. on the low flat coastal plain of southern Alaska that is fed by ice streams pouring from the lofty St. Elias Range to the N. The principal feeder is the Seward Glacier which gathers chiefly in a large intermontane basin well back in the highest part of the range. This basin, roughly 35 mi. long by 20 mi. wide, lies at elevations between 5,000 and 7,000 ft.

Saskatchewan Glacier is one of the principal outlet ice streams of the Columbia Ice Field on the boundary between Banff and Jasper national parks in the Canadian Rockies of Alberta. The Saskatchewan has a geometrically simple ice tongue extending in a nearly straight channel of fairly uniform cross section roughly 5.5 mi. below the firn edge. It has only one attached tributary.

The Blue is small valley glacier draining from the NE. slope of Mount Olympus in the heart of the Olympic Peninsula of northwestern Washington. It is only 2.6 mi. long but has a 1,000-ft. icefall and a high material turnover related to heavy winter snows and strong melting in summer.--From introd., p. 4, 7.

Chapters cover the constituent parts of a glacier, the glacier budget, glaciers and climate, conversion of snow to glacier ice, flow of glaciers, structures in glaciers, oxygen-isotope ratios, and the future.

3-3219. Case, James B. GLACIER MAPPING IN THE WESTERN UNITED STATES: FINAL REPORT: 11 p., 6 maps (4 in pocket), Columbus, Ohio, Ohio State University Research Foundation, Jan. 1960, 9 refs.

The program for mapping glaciers in the western United States was begun in 1959 and included carrying out field surveys, obtaining aerial photography, and plotting maps for the following glaciers: Palisade and Powell in the Sierra Nevada of California; Whitney on Mt. Shasta in northern California; Collier on the Three Sisters and Eliot on Mt. Hood, both in Oregon; Dinwoody in the Wind River Range of Wyoming; and Plateau and Burroughs in Glacier Bay National Park, Alaska. An effort was made to choose glaciers on which research was being or had been carried out so that the maps would be of immediate use to others. The glaciers are meant to be representative of their area and are distributed geographically throughout the western United States without duplicating mapping work being done by other organizations.

All mapping for this project was completed from aerial photography. For each glacier an approximate position, orientation, and elevation datum was determined from available medium-scale topographic maps of the U. S. Geological Survey. The map manuscript of the Powell Glacier was prepared at a scale of 1:2,000 with a contour interval of 2 m. on the glacier surface and moraines and 10 m. elsewhere. All other maps were prepared at 1:5,000 with contour intervals of 5 and 25 m. Copies of the maps are included in this report, the map of the Powell Glacier being reduced to the 1:5,000 scale.--L. M. Dane.

3-3220. Zumbege, James H., and others. DEFORMATION OF THE ROSS ICE SHELF NEAR THE BAY OF WHALES, ANTARCTICA: IGY World Data Center A, Glaciology, IGY Antarctica. Rept. Ser. no. 3, 148 p., 35 figs., 16 tables, May 1960, 67 refs.

Parallel crevasses oriented normal to the axes of firn folds in the Ross Ice Shelf between Roosevelt Island and the Bay of Whales, Antarctica, were studied during the IGY 1957-1958 and 1958-1959. Seismic soundings reveal that the ice shelf ranges from 70 m. to 133 m. in thickness in the area of intense folding and heavy crevassing and is floating in sea water more than 500 m. deep. The folds and associated crevasses are produced by horizontal compressional stresses which are induced by the merging of 2 ice streams after they flow around the E. and W. sides of Roosevelt Island. The density-depth profile of the upper 15 m. of firn in the folded area reveals higher densities than those found at the same depths in other cold glaciers of the world. The increased densification in the folded parts of the shelf ice is attributed to plastic deformation resulting from lateral compressive stresses.

Strain rates show that the axes of the firn folds are almost always perpendicular to the principal compressive axis and that the crevasses are essentially

perpendicular to the principal tension axis. An exception exists in the vicinity of the anticlinal crests where the crevasses make a considerable angle with the principal stress axes. A comparison of strain rates in crevassed and noncrevassed areas defines a rupture criteria which takes the mathematical form of a surface of revolution around the line $s_1 = s_2$. An estimate of the anticline's age based on strain data gives a value of 20-30 years.

A thin ice layer in the study anticline was also deformed and displayed a moderately strong preferred crystal orientation. The maximum concentration of the c-axes is 8% to 9% per 1% of the area. Fabric diagrams plotted on a Schmidt equal-area net generally show 4 maxima 12° to 17° from the equator, and inclined 20° from one of the planes of principal shear but essentially normal to the other shear plane. The crystal fabric of a pygmatic fold on one of the anticlinal limbs suggests a mechanism of deformation involving differential slip along the basal plane which is nearly parallel to the axial plane of the anticline. --Auth.

3-3221. Dreimanis, Aleksis. TILLS OF SOUTHERN ONTARIO (In: Legget, Robert F., ed. Soils in Canada: Royal Soc. Canada, Spec. Pub. no. 3, p. 80-96, 8 figs., 3 tables, 1961) 28 refs.

Results of granulometric and lithologic analyses of 600 till samples are summarized in 45 arbitrary areal and stratigraphic units. Their review suggests that incorporated older Pleistocene deposits and bedrock fragments, particularly those of local bedrock, share in composition of tills of southern Ontario. As limestone and dolostone are the dominant bedrock types here, tills are highly calcareous, with carbonate particles concentrated particularly in the coarse sand to cobble grade and another maximum in the silt and clay grade. Relatively lower carbonate content is along the SW. side of the shale bedrock areas.

Most of the older tills are medium to coarse textured. Tills of the latest glacial readvances are clayey and silty in the lake basin areas because of incorporation of lacustrine sediments, while the upper tills on higher ground in between Great Lakes have greater textural variety. --Auth.

3-3222. Bolton, Thomas E., and Patrick K. Lee. POST-GLACIAL MARINE OVERLAP OF ANTICOSTI ISLAND, QUEBEC: Geol. Assoc. Canada, Proc., v. 12, p. 67-78, map, table, Dec. 1960, 20 refs.

Surficial deposits of marine origin are present on Anticosti Island only as high as 250 ft. above sea level. Total or slightly limited postglacial inundation had been postulated by previous investigators. Numerous terraces and raised beaches are discernible. Glacial features noted through air photograph evaluation and ground survey include a thin mantle of till covering the bedrock above 250 ft. and scalloping and fluting in both the eastern and western parts of the island. --Auth.

3-3223. Dreimanis, Aleksis. THE EARLY WISCONSIN IN THE EASTERN GREAT LAKES REGION, NORTH AMERICA: Deutsche Akad. Wissenschaften, Berlin, Klasse 3, no. 1, p. 196-205, map, 3 tables, 1960, 49 refs.

The beginning of the Wisconsin ice age is extended beyond the Farmdale substage of the classical Wisconsin. Evidences of the following subdivisions of the Wisconsin have been found in the eastern Great

Lakes region (beginning with oldest and not including substages of the classical Wisconsin): 1) an early Wisconsin glaciation, including interstadials, for instance the St. Pierre, during its oscillatory advance; the Olean drift is considered an early Wisconsin deposit; 2) the Port Talbot interstadial; 3) the mid-Wisconsin glacial advance; 4) the Plum Point interstadial; 5) the main Wisconsin glaciation, equivalent to the classical Wisconsin.

The Sidney interstadial in Ohio probably embraces the Port Talbot and the Plum Point interstadials, including also the mid-Wisconsin glacial advance which separates them N. of Lake Erie.

The centers of glacial outflow were farther E. during the early Wisconsin than during the maximum of the main or classical Wisconsin.

A tentative correlation is given with the various subdivisions of the Würm ice age in Europe. --Auth.

3-3224. Frye, John C., and H. B. Willman. CONTINENTAL GLACIATION IN RELATION TO McFARLAN'S SEA-LEVEL CURVES FOR LOUISIANA: Geol. Soc. America, Bull., v. 72, no. 6, p. 991-992, fig., June 1961, 4 refs.

McFarlan's sea-level curve for Louisiana is compared with an interpretative glacial-advance curve for the Wisconsin of the Lake Michigan glacial lobe. A significant ice withdrawal during Farmdale time is not recorded in the sea-level curve. World-wide glacial fluctuations should be reflected in sea-level variations when sufficient data become available from both environments. --Auth.

3-3225. Scheidegger, Adrian E. THEORY OF ROCK MOVEMENT ON SCREE SLOPES: Alberta Soc. Petroleum Geologists, Jour., v. 9, no. 4, p. 131-138, 140, 4 figs., Apr. 1961, 7 refs.

The phenomenon of dry rock movement on scree slopes is investigated. The generally held assumption that such movement is caused by the volume expansion and contraction due to daily and seasonal temperature fluctuations is analyzed. It is shown that a reasonable physical theory can be based upon this assumption. --Auth.

3-3226. Schumm, Stanley A. EFFECT OF SEDIMENT CHARACTERISTICS ON EROSION AND DEPOSITION IN EPHEMERAL-STREAM CHANNELS: U. S. Geol. Survey, Prof. Paper 352-C, p. 31-70, 41 figs., 8 tables, 1961, 18 refs.

This study of 5 semiarid valleys emphasizes the importance of physical properties of sediment in determining stream-channel shape and differences in the mechanics of erosion and deposition between areas. Prerequisites for selection of the 5 areas were a progressive decrease in the percent silt-clay in stream channels and banks, active aggradation or erosion within a reach of the stream channel, and nearly uniform lithology within each drainage basin.

A comparison of the data obtained from each area demonstrates that in a drainage channel composed of fine-grained, highly cohesive sediment, deposition occurs on the sides of the channel as well as on the channel floor. The result is a reduction in the channel width-depth ratio across an aggrading reach. Vegetation seems to aid deposition by its rapid growth on recently deposited fine alluvium, but it is not the initial cause of aggradation. Bank caving yields only small amounts of sediment, and caved blocks are often nuclei for deposition along channel sides because

of their resistance to disintegration. Degradation in the finer sediments is generally by upstream headcut migration.

In contrast, those channels containing only small amounts of silt-clay are aggraded from bottom to top. No plastering of fine sediments on the banks occurs. Less vegetation grows on these poorly cohesive, highly mobile sediments. Headcutting occurs only where the coarser sediments are capped by a layer of fine material. In general, a break in the longitudinal profile of this type channel is quickly removed by channel degradation. Bank caving seems to supply more sediment to the stream load, for the blocks of poorly cohesive alluvium disintegrate upon impact.

Deposition causes marked changes in the ephemeral-stream channels. As the reach of maximum aggradation is approached channel gradient decreases, and depending on the amount of silt-clay in channel and banks, the width-depth ratio may increase or even decrease. In all channels studied percent silt-clay increases and median grain size decreases with aggradation. At the lower end of an aggrading reach, the gradient steepens, but sediment is still fine and vegetation generally covers the entire valley floor. The reach of maximum deposition may migrate upstream with time, but renewed degradation on the downstream reach of steep gradient may cause a trench to cut through the valley plug, renewing through transport of sediment and runoff.

The aggradation in the study areas is apparently a result of high sediment yields in the headwater parts of the drainage basins. Deposition in the channel occurs, however, where the rate of increase of drainage area per mile of channel length is low. In these reaches of small tributary contribution, water loss into the alluvium and the subsequent increase in sediment concentration causes deposition.

The shape of stable cross sections, expressed as a width-depth ratio, is dependent on the weighted mean percent silt-clay in banks and channels such that width-depth ratio increases with decreased silt-clay in the alluvium. Gradient also shows an inverse relation to weighted mean percent silt-clay for these small streams of low annual discharge.

It is suggested that the relation between channel shape and silt-clay can be used as a criterion of channel stability, for aggrading channels generally plot well above the width-depth, silt-clay regression line, whereas, degrading channels plot below the line.

The study suggests that preventive conservation may be the most practical solution to some erosion problems, such as arroyo cutting. Deposition, if it is desired to fill a trenched channel, should be induced in reaches where conditions are most favorable for natural aggradation. Conservation measures should be modified depending on the character of the valley and its alluvium. Only certain critical reaches of a channel need be controlled to prevent erosion over larger areas.--Auth.

3-3227. Blanc, Robert P., and George B. Cleveland. **PLEISTOCENE LAKES OF SOUTHEASTERN CALIFORNIA:** California, Div. Mines, Mineral Inf. Service, v. 14, no. 4, p. 1-8, no. 5, p. 1-6, 6 illus., 2 maps, Apr. and May 1961, 21 refs.

A brief geological and geographical review of the Pleistocene basins in the desert region of southeastern California. Each of 3 principal drainage courses - the Owens, Amargosa, and Mojave - and their ancient counterparts, are traced. Evidence is presented which suggests a possible connection between these

drainages and those of Lake Lahontan and the ancient Colorado River.

In the basins such important industrial materials as potash, gypsum, bromine, B, sodium sulfate and carbonate, calcium chloride, phosphate, salt, Li, pumicite, clay, and diatomaceous earth are found. The occurrence and origin of these materials at the principal deposits are briefly reviewed.--Auth.

3-3228. Sullivan, Walter. **THEORY IS REVISED FOR GREAT LAKES:** New York Times, v. 110, no. 37,801, p. 51, col. 1, July 23, 1961.

A great river emptying into either Hudson Bay or the St. Lawrence River valley, rather than continental glaciation, is postulated as the primary factor in the formation of the present Great Lakes basins. The new theory is based on study of cores from the bottom of Lake Superior and from records of a sub-bottom sounder.--M. Russell.

3-3229. Trainer, Frank W. **EOLIAN DEPOSITS OF THE MATANUSKA VALLEY AGRICULTURAL AREA, ALASKA:** U.S. Geol. Survey, Bull. 1121-C, 34 p., 6 figs., 1961, 43 refs.

Wind-blown silt and sand in the Matanuska Valley agricultural area of S.-central Alaska constitute widespread deposits that are still being formed. The modern eolian sediment is blown chiefly from bare glacial-outwash flood plains, and locally from exposures of older eolian deposits and sandy glacial drift; it is deposited in nearby vegetation, which is largely forest. The formation of crusts of sediment in bark and on fallen leaves helps hold the fresh dust in place until it becomes incorporated in the soil; these crusts are formed by alternate wetting and drying in summer and autumn and by the melting of dust-laden snow in winter and spring. Once covered by vegetation, the material is stable except in roads, excavations, and cultivated fields, where it is eroded by wind. Erosion by water is unimportant even in fields, probably because the silt and sand are porous and permeable and because rainfall intensity is low. In general the sandy eolian deposits occur beside modern or late-glacial flood plains; the silt is widely distributed over the more distant terrain. In one part of the area sand in dunes and horizontal beds beside a bare flood plain and silt farther from the plain are facies of a single sedimentary unit. Deposition of the eolian sediment began during or after recession of the last glacial ice (probably of late Wisconsin age) that covered this area. The character of the deposits shows that the direction and intensity of winds, the source areas, and the environment of deposition have been similar to those of the present throughout the period of deposition, and strongly suggests that there has been no major interruption of deposition since it began. Thin buried humus bands and other stratigraphic features in the deposits may indicate repeated brief episodes of flood-plain stability, however. These inferred periods of stability are thought to have followed changes in outwash-stream regimen, which in turn were related to growth and shrinkage of the glaciers or to eustatic changes in sea level. The essentially continuous nature of the eolian deposition is believed to show that the principal streams have been glacial-outwash streams continuously since the last glaciation and, hence, that the major source glaciers did not melt completely after that glaciation.--Auth.

3-3230. Roth, Eldon S. **THE SILT-CLAY DUNES AT CLARK DRY LAKE, CALIFORNIA:** Compass,

v. 38, no. 1, p. 18-27, 7 illus., 3 figs., Nov. 1960, 6 refs.

Dunes composed of silt and clay-size material are found in many parts of the world. Those found at Clark Dry Lake are considered typical of many silt-clay dunes occurring in the southwestern United States. All of the dunes found at Clark Dry Lake appear to be lee dunes associated with vegetation, and all are smooth and streamlined in shape with no free slip surfaces. Instead the surfaces are much cracked, fairly hard, and composed of the same materials as those found in the surrounding playa. Cross sections cut through the dunes reveal an interior composed of loose, dry, sand-size aggregate particles and usually one or more former surfaces which appear as consolidated, hardened layers. Mechanical analyses of the dune material and the playa surface material give almost identical cumulative curves, while hand-sieved samples of aggregate particles give similar curves but in the sand size range.--Auth.

3-3231. Yakubov, T. F. NEW CONTRIBUTIONS TO THE STUDY AND CONTROL OF WIND EROSION OF SOILS: I. MECHANISM AND DYNAMICS OF WIND EROSION: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 7, p. 792-800, 3 figs., pub. 1961, 39 refs.

The immense agricultural losses caused by wind erosion in the United States and Canada stimulated the establishment of a number of experiment stations and various special wind tunnels and installations for the study of wind erosion processes in soils.

Through the use of wind tunnels and aerodynamic theories, definite progress was made in a comparatively short time in these countries in the explanation of the nature of wind erosion. Ideas were broadened about factors and dynamics of wind erosion development, the character of the soil-wind flow, and the forms of manifestation of wind erosion. Valuable data were obtained on the quantitative characteristics of wind transportation of soil masses by various methods of movement, etc.

The use of wind tunnels, and also laboratory and field experiments gave rise to new data on the physical-chemical properties of soils which favor or resist the development of wind erosion. They explained the effects of soil surface characteristics, vegetation and its residues, and methods of soil cultivation on the development of wind erosion. In the final analysis, all this made possible a more fundamental approach to the development of practical methods for protecting soils from wind erosion, which brings great harm to the agriculture of arid regions.--Auth. concl.

3-3232. Yakubov, T. F. NEW CONTRIBUTIONS TO WIND SOIL EROSION AND ITS CONTROL: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 11, p. 1312-1322, fig., 7 tables, pub. 1961, 24 refs.

Factors affecting the erodibility of soil material by wind include cloddiness of the soil, relative quantity of water-stable aggregates, texture, content of calcium carbonate, and amount of organic substances. The effects of variations in these factors are analyzed.--M. Russell.

3-3233. Nogina, N. A., and T. A. Rode. INFLUENCE OF ROCKS UPON SOIL FORMATION PROC-

ESSES: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 10, p. 1157-1164, 3 tables, pub. 1961.

The influence of rocks which have a very low content of alkaline earth bases and an acidic reaction on soil formation processes in different soil-climatic zones is great and highly singular. Greater attention must be paid to the influence of underlying rocks in order to identify relict residual soils from what has been acquired in the process of recent soil formation. The classificational position of soils formed on rocks deficient in alkaline earth bases must be defined from the zonal point of view.--M. Russell.

3-3234. Legget, Robert F., ed. SOILS IN CANADA; GEOLOGICAL, PEDOLOGICAL, AND ENGINEERING STUDIES: Royal Soc. Canada, Spec. Pub. no. 3, 229 p., illus., maps, diags., graphs, tables, Toronto, University of Toronto Press, 1961, refs.

The papers in this volume were presented as a symposium which formed part of the program for Sec. 4 (Geological and Allied Sciences) of the Royal Society of Canada at its annual meeting held at Queen's University, Kingston, Ontario, in June 1960.

The volume starts with a general review of the present state of knowledge regarding the Pleistocene geology of Canada. Against this background 6 regional geological studies follow, each dealing with a distinct area in which soils with varying geological histories are encountered. The importance of the relatively new study of muskeg, and its significance to Canada, is indicated by the next paper which serves as an introduction to the work already done in this field by its author. All soil studies are dependent to some degree upon soil mineralogy which is therefore the subject of the next paper, a summary being presented of the results of recent research.

Soils are next considered from the pedological viewpoint starting with a broad review of the position of pedological studies in Canada today. Two papers follow dealing with major agricultural soil groups of importance in Canada, followed by a paper describing in general terms the soils met with in an important agricultural region of Ontario.

Four papers dealing with soils from the engineering point of view complete the volume, the first being closely linked with the preceding pedological papers in that it illustrates how the results of agricultural soil studies are being put to use by engineers. A somewhat unusual aspect of the geology of soils is treated in the paper describing the influence of geology on the design and construction of airports. As an example of the detailed studies now being made (in soil mechanics laboratories) of some of the soils that are peculiar to Canada, a summary of research into the properties of the Leda clay is next presented, this being a companion paper to the geological review of the soils of the Champlain Sea. The volume is brought to a close by a general review of soil problems as encountered in civil engineering in Canada and their correlation with geology.--From introd. by R. F. Legget.

The papers are listed below:

Geology of the Soils of Canada, by V. K. Prest.
Soils of the Coastal Area of Southwest British Columbia, by J. E. Armstrong.
Glacial Deposits of Alberta, by C. P. Gravenor and L. A. Bayrock.
Soils of the Lake Agassiz Region, by John A. Elson.
Tills of Southern Ontario, by Aleksis Dreimanis.
The Champlain Sea and Its Sediments, by P. F. Karrow.

Glacial Geology and the Soils of Nova Scotia, by H. L. Cameron.
 Organic Terrain, by Norman W. Radforth.
 Clay Mineralogy of Canadian Soils, by S. A. Forman and J. E. Brydon.
 The Soils of Canada from a Pedological Viewpoint, by A. Leahey.
 Characteristics and Genesis of Podzol Soils, by P. C. Stobbe.
 Genesis and Characteristics of Solonchic Soils, With Particular Reference to Those of Alberta, Canada, by W. Earl Bowser.
 The Soils of Southern Ontario, by N. R. Richards.
 Correlation of Engineering and Pedological Soil Classification in Ontario, by A. Rutka.
 Influence of Geology on the Design and Construction of Airports, by Norman W. McLeod.
 Engineering Studies of Leda Clay, by C. B. Crawford.
 Engineering Significance of Soils in Canada, by R. F. Leggett and R. M. Hardy.

3-3235. Selyakov, S. N. BURIED SOILS OF THE MIDDLE AND UPPER OLIGOCENE OF KULUNDA: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 12, p. 1445-1450, table, pub. 1961, 4 refs.

The paleogenic buried soils of western Siberia have not been given enough attention in the special literature, although a knowledge of them would provide a deeper understanding of the development of the landscapes of Siberia in the Paleogenic. In this paper we describe the morphology of the middle and upper Oligocene buried soils found among strata of the Atlymsk, Novomikhaylovsk, and Zyatkovsk subsuite of the Nekrasov suite (continental rocks of the middle and upper Oligocene).

In Kulunda during this period, podzolic soils developed on elevated relief, and clayey bog soils, meadow-bog soils, and meadow soils developed in depressions. The podzolic soils are typical and sod-podzolic groups, sometimes with evidence of gleization.

The soils of depressions vary greatly in humus content, the thickness of the humus horizon, and in gleization, and they may be noncarbonate or have carbonate horizons. Among the soils of depressions we find types that resemble in structure modern solonchic soils or the structural soils of river terraces.

The soils developed in boundaries of a forest zone. During the formation of the strata of the Novomikhaylovsk and Zyatkovsk subsuite of the Nekrasov suite, conditions were favorable for the local accumulation of calcium carbonates in the soils of the depressions.--Auth. introd. & concl.

3-3236. Aleksin, A. A. THE IMPORTANCE OF THE CRYPTO-GEOLOGICAL STRUCTURE OF CENTRAL ASIAN ALLUVIAL PLAINS FOR RECLAMATION PURPOSES: Pochvovedeniye, Soviet Soil Sci., in translation, 1960, no. 2, p. 135-140, fig., table, pub. 1961, 6 refs.

A relation is shown between the variations in texture of sediments in the Amu Darya river valley, Central Asia, and the buried geologic structure, which in turn are reflected in clearly defined zones of contemporary tectonic movements. In order to reclaim salinized land it will be necessary to irrigate on structural highs and rely on ground-water flow to flush salts to drainage collectors prepared in the structural lows.--M. Russell.

3-3237. Kovda, V. A. and G. V. Zakharina. GEO-CHEMICAL PROPERTIES AND PROCESSES OF SALT ACCUMULATION IN SINKIANG SOILS: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 9, p. 1009-1011, pub. 1961.

The deserts of Sinkiang, China, are characterized by basin and range topography. A constant flow of artesian water results in high rate of evaporite accumulation, sodium carbonate in particular. Continuous salt accumulation from Tertiary time is indicated. Regional development will require large-scale cooperation in irrigation, drainage, and natural resources exploitation.--M. Russell.

3-3238. Doskach, A. G. CLASSIFICATION OF FINE AND MEDIUM RELIEF SPACES [SIC]: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 12, p. 1422-1428, pub. 1961, 9 refs.

The classification of sculptural forms into 2 groups - small and medium - is based not only on their dimensions but on the nature of the process of relief formation, its complication in the development process, and the different duration of the process.

Nano-, micro-, and meso-forms of relief types having one and the same genesis can be considered as different stages of the process of development of a given type of morpho-sculpture. The decay of individual stages, the acceleration or retardation of development may be due to local characteristics of relief formation conditions and the greater or lesser intensity of the action of the main factor (or factors) of relief formation.

Together with the small forms, representing the early stages of development of the large relief forms, other types of small relief are also widespread. These, passing fairly quickly through part of their development, persist for a long time without much change at a certain stage under certain physiographic conditions, and develop with them. They are, to a certain degree, leading zonal, environmental, etc. forms.

The persistence of certain types of small and medium forms without great variations does not represent arrested development, but is the result of the conformity of the given forms and types to the conditions of their existence. Intense relief development and reconstruction are usually the result of a disturbance of this conformity.

The concrete classification of relief forms according to size involves a certain arbitrary approach to the quantitative limits in passing from one size category to another. This arbitrary approach results from the very nature of things and is not in conflict with the necessity for standardizing the main indices for obtaining comparable material for mapping.--Auth. concl.

3-3239. Kats, N. Ya. BOGS AND PEATS OF NORTH AMERICA: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 10, p. 1165-1171, fig., pub. 1961, 21 refs.

A general account and map of types of bogs occurring in the United States and Canada is given. The author recognizes, describes, and maps the following 7 types: 1) bog zones with permafrost; 2) raised oligotrophic sphagnum bogs; 3) eutrophic forest bogs with broad-leaf trees; 4) tall-grass bogs subject to flooding; 5) eutrophic forest bogs with tertiary tree species; 6) territories with few bogs of eutrophic type; 7) mountainous areas with bogs on ridges, slopes, valleys and hollows.--M. Russell.

3-3240. Frankel, Larry, and G.H. Crowl. DROWNED FORESTS ALONG THE EASTERN COAST OF PRINCE EDWARD ISLAND: CANADA. *Jour. Geology*, v. 69, no. 3, p. 352-357, 3 illus., 3 figs., May 1961, 15 refs.

Intertidal peats and radiocarbon-dated tree stumps in eastern Prince Edward Island indicates 5-8 ft. of submergence during the last 900 years. Submergence may be due to eustatic rise of sea level or to possible tilting of the island.--Auth.

3-3241. Roberts, Carlyle J., ed. **PHYSIOGRAPHY AND CLIMATOLOGY OF THE ATLANTA AREA; An Excerpt From the Safeguards Report for the Georgia Tech Research Reactor: Georgia Inst. Technology, Eng. Expt. Sta., Bull. 24, p. 23-61, 18 figs., 10 tables, 1960, 15 refs.**

In Feb. 1960, the Georgia Institute of Technology

submitted to the U.S. Atomic Energy Commission an application for a license to build and operate a nuclear reactor for research and educational purposes. In support of this application, a Safeguards Report was submitted for review by the AEC's Hazards Evaluation Branch. Those sections of the report which describe the Atlanta area in general seemed to be of sufficient interest and wide applicability to warrant making them more readily available by issuing the information as a separate bulletin.

Much of the information concerning topography, geology, and hydrology was prepared by Don B. Jones; the climatological and meteorological summary is the work of the Meteorological Research Dept., Lockheed Nuclear Products, Lockheed Aircraft Corp., Atlanta.--From pref.

The report is in 5 sections: 1) topography and drainage; 2) geology, hydrology and water supplies; 3) climatology and meteorology; 4) seismology; 5) population analysis.

3. STRUCTURAL GEOLOGY

See also: Stratigraphy 3-3255; Geophysics 3-3321; Igneous and Metamorphic Petrology 3-3397; Sedimentary Petrology 3-3401.

3-3242. Donath, Fred A. **EXPERIMENTAL STUDY OF SHEAR FAILURE IN ANISOTROPIC ROCKS: Geol. Soc. America, Bull., v. 72, no. 6, p. 985-989, 7 figs., table, June 1961, 3 refs.**

Preliminary work has shown that planar anisotropy (foliation) may have a marked effect on both the breaking strength and the angle of shear fracture in rocks. For rocks experimentally deformed at room temperature and under low confining pressure, curves of breaking strength versus inclination of anisotropy are concave upward and parabolic in form. Shear fractures tend to develop parallel to well-developed planar anisotropy for inclinations up to 45°-60° to the direction of maximum pressure.--Auth.

3-3243. Campbell, F.H., III, and J.M. Cole, Jr. **A RE-EVALUATION OF A DIABASE DIKE NEAR GREENVILLE, AUGUSTA COUNTY, VIRGINIA: Compass, v. 38, no. 2, p. 69-77, 2 illus., 2 figs., table, Jan 1961, 13 refs.**

An olivine diabase dike near Greenville originally reported as 2 isolated igneous occurrences, has been mapped geologically and geophysically. Geologic mapping extended the known length of the dike by 2.2 mi. and defined its structural relationships. Magnetic surveying provided information on the width, length, attitude, and precise location in covered areas. Magnetic profiles indicate changes in attitude from place to place along the dike trend.

Similar surveys are recommended for investigation of other intrusives in the Appalachian Valley province, and congeneric terranes.--Auth.

3-3244. Paterson, M.S., and L.E. Weiss. **SYMMETRY CONCEPTS IN THE STRUCTURAL ANALYSIS OF DEFORMED ROCKS: Geol. Soc. America, Bull., v. 72, no. 6, p. 841-882, 17 figs., 6 tables, June 1961, 63 refs.; abs. in French, Spanish, German, and Russian.**

Bruno Sander has proposed that the fabric symmetry of a deformed rock reflects the kinematic symmetry of its deformation. In order to place this sym-

metry principle on a firmer basis, the background of the symmetry theory of fabrics is here reviewed. From very general notions of symmetry as a starting point, fabric symmetry is shown to be a statistical space symmetry consisting of a point group of symmetry operations combined with arbitrary translations in all directions. Where likely restrictions are placed upon the point groups to be expected in homogeneously deformed rocks, the usual types of symmetry observed in fabrics of deformed rocks (namely, spherical, axial, orthorhombic, monoclinic, and triclinic) remain as possible types. The general derivation demonstrates that apart from pseudocrystallographic symmetries defined by some crystallographic fabric elements, no other types of fabric symmetry can be expected in homogeneously deformed rocks.

Attention is drawn to the relevance to the views of Sander of Curie's principles governing the symmetries of "cause" and "effect" in physical phenomena. The features of a deformed rock that define its fabric are found to be a 3-dimensionally ordered array of discontinuities in structure (lattice planes and lines in crystals, grain boundaries, foliations, lineations, folds, and so on) which may be viewed as the "effect" of deformation. These surfaces and lines of discontinuity in structure are generally sites of surfaces and lines of discontinuity in deformation - implicit in Sander's concept of componential movements - which collectively define the "movement picture" (Bewegungsbild) of the deformation. An attempt is made to state more precisely the significance of a movement picture in terms of analysis of local heterogeneities and perturbations in deformation that reflect or are responsible for the development of fabric features in a statistically homogeneously deformed aggregate. The kinds of symmetry observed in tectonite fabrics are found also to be the only kinds possible in movement pictures of homogeneous deformations.

Curie's principles may now be restated in a form directly applicable in the interpretation of tectonite fabrics, thereby amplifying Sander's principle. Without qualification, the most important principle may be restated as follows: whatever the nature of the factors contributing to a deformation may be, the symmetry that is common to them cannot be higher than the symmetry of the deformed fabric, and sym-

metry elements absent in this fabric must be absent in at least one of the contributing factors.--Auth.

3-3245. Berthelsen, Asger. AN EXAMPLE OF A STRUCTURAL APPROACH TO THE MIGMATITE PROBLEM: Greenland, Geol. Undersøggelse, Misc. Papers no. 28, 9 p., 3 figs., table, 1960, 9 refs.; reprinted from: International Geological Congress. 21st, Copenhagen, 1960. Report, Pt. 14, p. 149-157.

Original paper was abstracted as GeoScience Abstracts 3-2205.

3-3246. St. John, Bill. THEORIES OF CONTINENTAL DISPERSION: Compass, v. 38, no. 2, p. 91-97, Jan. 1961, 26 refs.

Continental dispersion has long been a source of discussion in the natural sciences. Arguments have not been restricted to the scientists of either today or yesterday. During the 1920's the dispute waged hot and heavy, and today dispersion once again shows signs of becoming a bone of contention. Many so-called facts have been offered time and again to either prove or disprove the possibility of continental dispersion.

Whether or not dispersion has occurred perhaps is not as important as the amount of original thinking which has centered about the subject. Research so far has not proved the concept one way or the other but has doubtless revealed other useful facts.

If geologists can prove by detailed mapping of the continental coastlines and by use of palinspastic maps

that the continents were formerly joined as an entity, then the physicists and mathematicians can proceed to discover why and how this separation has occurred.--Auth.

3-3247. SPLIT BOTTOM LOWERS SEAS: Sci. News Letter, v. 80, no. 2, p. 23, July 8, 1961.

Post-Eocene enlargement of rifts in mid-oceanic ridges are postulated to explain a sea-level drop of 1,500 ft. deduced from Caribbean terraces.--M. Russell.

3-3248. Green, L. H., and Kenneth C. McTaggart. STRUCTURAL STUDIES IN THE MAYO DISTRICT, YUKON TERRITORY: Geol. Assoc. Canada, Proc., v. 12, p. 119-134, 9 figs., Dec. 1960, 18 refs.

Small folds and other minor structures observed in the mapping of Keno and Galena hills of the Mayo district, Yukon Territory, indicate intense deformation, large-scale overturned isoclinal folds, and low-angle faults. Mapping in the Davidson Range to the N. of Keno and Galena hills has shown the presence of a large-scale overturned fold. The overturned isoclinal folds are believed to have formed during an early period of deformation. In part of the district the axes of these early folds are believed to have been rotated in a later period of deformation characterized by open folding, faulting, and the development of a wrinkle lineation. Faults containing the important Ag-Pb-Zn deposits of the district were developed after these deformations.--Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 3-3190; Areal and Regional Geology 3-3212; Paleontology 3-3274, 3-3275, 3-3287, 3-3304, 3-3305, 3-3309; Mineralogy 3-3386; Sedimentary Petrology 3-3401; Fuels 3-3477; Engineering Geology 3-3539.

3-3249. Hixon, S. B. SEDIMENTATION ASPECTS OF THE CHIBOUGAMAU GROUP: A POSSIBLE PRE-CAMBRIAN TILLITE: Compass, v. 38, no. 2, p. 107-114, 4 illus., map, table, Jan. 1961, 8 refs.

The Chibougamau group of unmetamorphosed sedimentary rocks occurring in central Quebec is considered to be Precambrian in age. It is divided into 3 formations: the Nepton conglomerate at the base, the Gaston formation in the middle, and the Bourbeau conglomerate at the top. The total thickness is more than 3,000 ft. A number of distinctive features suggest a glacial origin with the source of the material being to the N.--Auth.

3-3250. Lemon, R. R. H. PROTEROZOIC AND PALAEOZOIC STRATIGRAPHY OF ADMIRALTY INLET REGION, BAFFIN ISLAND: Royal Can. Inst., Trans., v. 33, pt. 1, no. 68, p. 3-13, map, sec., table, Oct. 1960, 13 refs.

A threefold stratigraphic succession is established in the Admiralty Inlet region of northern Baffin Island. Above the Proterozoic Egalulik group of Blackadar is the Uluksan group, also of Proterozoic age, subdivided into 5 formations: Arctic Bay, Society Cliffs, Victor Bay, Strathcona Sound, and Elwin formation.

The Uluksan group is overlain unconformably by the Admiralty group in which 4 formations are rec-

ognized: Gallery, Turner Cliffs, Ship Point, and Bailarge Bay formation. The 2 lower formations are lacking in zone fossils and are of doubtful Lower or Middle Ordovician age. The 2 formations contain a scanty fauna of Red River type. On the basis of this fauna, correlations are suggested with Ordovician rocks on Devon Island, at Silliman Fossil Mountain in southern Baffin Island, and elsewhere in the eastern Arctic.

The Admiralty group begins with sandstones of terrestrial origin and passes up into pure marine limestones, while there is a progressive overlap of higher formations southward until dolomites of the Ship Point formation come to rest on the Archean in the southern Admiralty Inlet region.

It is suggested that during Lower and possibly part of Middle Ordovician time this region of northern Baffin Island was a land area lying to the S. of the Jones-Lancaster basin. The Admiralty group sediments mark the initial stages of a marine transgression which culminated in the widespread deposition of sediments containing the Red River fauna.--Auth.

3-3251. Ollerenshaw, N. C., and R. W. Macqueen. ORDOVICIAN AND SILURIAN OF THE LAKE TIMISKAMING AREA: Geol. Assoc. Canada, Proc., v. 12, p. 105-115, map, 3 tables, Dec. 1960, 25 refs.

Ordovician strata of the Lake Timiskaming [Ontario-Quebec] outlier contain the "arctic Ordovician" faunal assemblage, and are correlated with the Red River formation and its equivalents, the age of which is discussed. A study of the coral fauna of the Silurian of the outlier has afforded evidence supporting a

Clinton rather than Lockport age for the strata of the Thornloe formation.--Auth.

3-3252. Langenheim, Ralph L., Jr. THE PILOT SHALE, THE WEST RANGE LIMESTONE, AND THE DEVONIAN-MISSISSIPPIAN BOUNDARY IN EASTERN NEVADA: Illinois, State Acad. Sci., Trans., v. 53, no. 3/4, p. 122-131, 3 figs., 1960, pub. 1961, 17 refs.

The most important conclusion of this study is that the nonresistant, buff-weathering, poorly exposed rocks between the Late Devonian cliff-forming carbonate beds and the Early Mississippian crinoidal limestone may profitably be assigned to at least 3 rock units - West Range limestone, Lower Pilot shale, and Upper Pilot shale. In addition, all except the Upper Pilot shale contain Devonian brachiopods. These units appear conformable with and in part show intertonguing relationships with the underlying Devonian carbonate rocks, but a disconformity is present below the Mississippian crinoidal limestone. Overlap of the detrital rocks by the Joana and/or Monte Cristo limestone in the Cherry Creek-Pequop-Gold Hill area and on the shelf in southern Nevada indicates earlier positivism on the shelf and in a large area of northeastern Nevada. This conclusion is reinforced by facies changes toward more and coarser detrital material in the upper Guilmette limestone to Lower Pilot shale interval in these areas. Local, pre-Joana positivism is also indicated in the Duckwater, Lund, and Cave Valley region.

Several problems seem to have clear priority for further investigation. The Late Devonian faunas require systematic description and thorough stratigraphic study in order that the various facies of the Late Devonian formations may be placed in a biostratigraphic and temporal relationship. The details of the complex facies relationships between the Guilmette limestone, West Range limestone, and Pilot shale are still not adequately understood. Finally, a thorough search for fossils, including the less widely studied groups, must be made in the Upper Pilot shale if its age is to be definitely determined.--From auth. concl.

3-3253. Elias, Maxim K. MARINE CARBONIFEROUS OF N. AMERICA AND EUROPE (In: Congrès pour l'Avancement des Études de Stratigraphie et de Géologie du Carbonifère. 4th, Heerlen, 1958, Compte Rendu, v. 1, p. 151-161, 8 figs., Maastricht, Netherlands, Editions "Ernest Van Aelst," 1960) 45 refs.

Correlation of the marine Carboniferous across the northern Atlantic indicates the necessity to revise the boundaries which delimit its major subdivisions.

Conspicuous change in fusulines indicates major hiatus between the Moscovian and Uralian of eastern Europe and their equivalents of North America. Occasionally developed intermediate beds with *Protriticites* are usually classified with the Uralian.

Schwagerina (*Pseudoschwagerina*) characterizes straddle formations between the Uralian and the Permian. Phyletic relationships of this genus have a bearing on the problem of the Uralian-Permian boundary.

The Namurian is best characterized by certain goniatites but in their absence by the contemporaneous smaller Foraminifera and conodonts. Placement of the Namurian at the base of the Moscovian results in splitting of the Chester in North America. The equivalents of the Namurian in eastern Europe are

classified with the Dinantian. Conodonts begin to play an important role in determination of the Carboniferous-Devonian boundary.

Rapid migration of some marine organisms determines their approximate contemporaneity in different parts of the world, and slow but thorough migration of others results in their entirely different stratigraphic position in regions separated by thousands of miles distances.

Stratigraphic significance of *Fusulina*, *Protriticites*, *Triticites*, *Schwagerina*, *Pseudoschwagerina*, *Paraschwagerina*, *Pseudofusulina*, *Edmooroceras*, *Eumorphoceras*, *Girtyoceras*, *Archimedes*, *Palaeocoryne*, and *Mesolobus* are reviewed.--Auth.

3-3254. Hacquebard, P. A. CONTRIBUTION TO THE STRATIGRAPHICAL COLLOQUIUM. A SUMMARY OF CARBONIFEROUS STRATIGRAPHY AND PALAEOLOGY OF THE MARITIME PROVINCES OF CANADA (In: Congrès pour l'Avancement des Études de Stratigraphie et de Géologie du Carbonifère. 4th, Heerlen, 1958. Compte Rendu, v. 1, p. 233-235, Maastricht, Netherlands, Editions "Ernest Van Aelst," 1960) 12 refs.

A brief account is given of the Carboniferous stratigraphy and paleontology of the Maritime region. The principal data are incorporated in a table, which summarizes the characteristic faunas, floras, and spore florules, as well as the general lithology of the different stratigraphic units. The assumed correlations with Europe and the United States are indicated, but these are on the basis of the megafossils only. Some alterations in these correlations, not shown in the table, but indicated by the small spore distribution, are illustrated in [the abstract below]. Remarks regarding the usage in Canada of the terms Mississippian and Pennsylvanian, and the position of these 2 "subsystems" in the Maritimes are also included.--Auth.

3-3255. Neale, E. R. W., and D. G. Kelley. STRATIGRAPHY AND STRUCTURE OF MISSISSIPPIAN ROCKS OF NORTHERN CAPE BRETON ISLAND: Geol. Assoc. Canada, Proc., v. 12, p. 79-96, 2 illus., 2 maps, sec., Dec. 1960, 29 refs.

Mississippian rocks outcrop: 1) along the W. coast, 2) along the N. coast and Salmon River valley, 3) in Aspy Valley. The area is largely a peneplaned upland surface, elevation 1,450 ft., underlain by pre-Mississippian granite and gneiss. Mississippian rocks chiefly occupy lowlands, partly bounded by fault line scarps.

The Horton, Windsor, and Canso groups are present. The Horton consists of 3 formations: Craig-nish-coarse red clastics, Strathlorne-fine gray clastics, Ainslie-fine to coarse red clastics. The Ainslie formation is conformably overlain by the Windsor group, which consists of gypsum, anhydrite, limestone, and clastics. The Canso group, fine clastics, is exposed only on the N. coast where it conformably overlies uppermost (Subzone E) Windsor.

Mississippian rocks were folded and block faulted. Deformation was largely controlled by movements of the basement rocks and varies from gentle folding in Aspy Valley to overturning and minor thrusting along the W. and part of the N. coasts. The Aspy fault, major fault of the area, cuts off Aspy Valley rocks from other Mississippian rocks of the area. It is located along a pre-Mississippian line of weakness and was probably first reactivated in Windsor time.

Mississippian topography did not resemble that

of the present. Distribution of Horton formations in Aspy and Salmon River valleys shows that the Horton basin extended across this part of the present upland surface. It may have covered most of the upland surface. In Aspy Valley each successive, conformable, NE.-dipping Horton and Windsor unit transgresses eastward onto pre-Mississippian rocks. Reconstruction of this part of the Horton-Windsor basin suggests it was tilted northeastward in post-Mississippian time and subsequently bevelled by erosion.--Auth.

3-3256. Ellzey, Robert T., Jr. MISSISSIPPIAN ROCKS ON THE WESTERN FLANK OF THE OKLAHOMA CITY UPLIFT, OKLAHOMA: Shale Shaker. v. 11, no. 8, p. 2-15, 3 maps, chart, 3 secs., 4 pls., Apr. 1961, 29 refs.

Mississippian rocks are divided into units on the basis of lithology and correlated with lithologically similar units in surrounding areas. They are assigned to the Osagean, Meramecian, and Chesterian-Springer (?) series. Kinderhookian rocks are believed to be absent. The Woodford formation of Upper Devonian age underlies Mississippian rocks throughout the area.

Osagean rocks are present only in the western and northwestern parts of the area. The configuration of the eastern limit of the Osage and contours of the "Mayes"-Sycamore isopach map suggest an extension of the Pre-Meramecian uplift of southeastern Oklahoma. The "Mayes"-Sycamore overlies the Osage, and the Woodford where Osagean rocks are missing. The upper beds grade southward from southern Kingfisher County into the lower part of the "Caney." This fact is significant when selecting a datum for structure and thickness maps and for cross sections.

Rocks called "Caney" are believed to be of both Chesterian and Meramecian age. The term is not satisfactory for use in the subsurface however. Chester limestones and shales are present in Caddo and Grady counties and grade eastward into the Goddard shale.

In accordance with recent opinions, the Springer, which overlies the Chester and Goddard, is included in the Mississippian systems. In the southeastern part of the area, the Springer is indistinguishable from the Goddard. The Springer-Goddard isopach map of the area is probably invalid for most purposes.

The Woodford and post-Osagean Mississippian rocks were truncated as a result of uplift to the E.--C. E. Branham.

3-3257. Ostrom, Meredith E., and Paul Edwin Potter. A CLAY MINERAL SEQUENCE AT THE MISSISSIPPIAN-PENNSYLVANIAN CONFORMITY IN THE ILLINOIS BASIN: Jour. Geology, v. 69, no. 3, p. 341-351, 6 figs., table, May 1961, 13 refs.

A weathered zone defined by progressive changes in oxidation, texture, and clay mineral composition occurs at the Mississippian-Pennsylvanian contact in the Illinois basin in Crittenden County, Kentucky. Geologic evidence indicates that this weathered zone most probably represents a truncated pre-Pennsylvanian weathering profile. Texture and oxidation features are similar in vertical distribution to those of modern soil profiles. The upward increase in relative abundance in the profile of mixed-layer hydrated and nonhydrated illite is similar to that described from modern soil profiles developed in shale and in glacial till.--Auth.

3-3258. Bode, Hans. DIE FLORISTISCHEN VERHÄLTNISSE AN DER WESTFAL/STEFAN-GRENZE

IM EUROPÄISCHEN UND US-AMERIKANISCHEN KARBON [Characteristics of the Flora of the Westphalian-Stephanian Boundary in the Carboniferous of Europe and the United States] (In: Congrès pour l'Avancement des Études de Stratigraphie et de Géologie du Carbonifère, 4th, Heerlen, 1958. Compte Rendu, v. 1, p. 49-58, 5 figs., 1960) 20 refs.; text in German.

Within the upper Carboniferous are marked and stratigraphically important distinctions: none of the typical Westphalian forms extend up into the Stephanian; none of the major Stephanian forms occur in the Westphalian flora.

The Westphalian flora still appears with clear distinctions and ecological niches in the Westphalian C. Exclusively Stephanian representatives occur even in the deepest Stephanian beds, in the Carboniferous of the Saar immediately above the Holz conglomerate, in the Carboniferous of southern France at Rive de Gier, and in analogous beds in other basins.

In between lies a transition zone wherein the Westphalian forms become sparser and gradually disappear, while the Stephanian elements, on the other hand, are gradually interspersed and ultimately occur exclusively.

This transitional section between the Westphalian and Stephanian is the *Neuropteris ovata* zone which has been placed in the overlying Westphalian. On the basis of flora, 3 stages can be distinguished. At the base one finds a predominantly Westphalian flora with a few Stephanian precursors, in the middle stage Westphalian and Stephanian forms are about equal, in the upper stage is a more or less pure Stephanian flora. In all 3 stages *Neuropteris ovata* is common.

The *Neuropteris ovata* zone should therefore not be placed in the Westphalian but rather in the Stephanian and as the latter's initial beds.--Auth., transl. by E. Lustig.

3-3259. Hacquebard, P. A., and others. DISTRIBUTION AND STRATIGRAPHIC SIGNIFICANCE OF SMALL SPORE GENERA IN THE UPPER CARBONIFEROUS OF THE MARITIME PROVINCES OF CANADA (In: Congrès pour l'Avancement des Études de Stratigraphie et de Géologie du Carbonifère, 4th, Heerlen, 1958. Compte Rendu, v. 1, p. 237-245, 6 figs., Maastricht, Netherlands, Editions "Ernest Van Aelst," 1960) 18 refs.

The geological ranges of small spore genera from coals and carbonaceous shales in strata of the Maritimes (equivalent to Namurian A and Westphalian A to D) is presented.

The presence of genera with restricted ranges permit a selection of certain spore combinations that are used in zoning the upper Carboniferous succession. Five spore divisions, 4 zones, and 4 subzones are recognized. The limits of the spore divisions are in agreement with the 6 floral zones represented. However, additional subzones not clearly marked by the megaflores are also indicated, and include the "Howley beds" of Newfoundland.

The spore distribution in the uppermost zones show that a revision of the boundary between Westphalian C and D may be warranted, not only in the Maritimes but also in Europe. A detailed comparison with the Saar shows that the Westphalian D is represented in the Maritimes not solely by the *Ptychocarpus unitus* zone, but may also include the underlying *Linopteris obliqua* zone.

In the lowermost stratigraphic unit of the upper Carboniferous, which contains a Namurian A floral assemblage, a Mississippian spore florule is pres-

ent. Provisional data obtained from the Pomquet River section only, shows that a correlation between the Canso group and the middle Chester series of the United States can be made. However, little resemblance was noted with presently known Namurian assemblages. Indirect evidence, therefore, points to an inclusion of the Namurian A with the Mississippian.--Auth.

3-3260. Bharadwaj, D.C. SPOROLOGICAL EVIDENCE ON THE BOUNDARIES OF THE STRATIGRAPHICAL SUBDIVISIONS IN THE UPPER PENNSYLVANIAN STRATA OF EUROPE & NORTH AMERICA (In: Congrès pour l'Avancement des Études de Stratigraphie et de Géologie du Carbonifère. 4th, Heerlen, 1958. Compte Rendu v. 1, p. 33-39, 6 figs., Maastricht, Netherlands, Editions "Ernest Van Aelst," 1960) 16 refs.

A number of recent, detailed, sporological studies on the coals of upper Pennsylvanian geological successions in Europe and North America lead to the view that the major variations in the spore assemblages are more or less in correspondence with the megaflostric stratigraphic subdivisions recognised in these regions. The spore assemblages characteristic of most of the Westphalian C, Westphalian D, lower Stephanian (A and B) and upper Stephanian (C) of Europe and N. America are given. It is concluded that sporologically the boundary between Westphalian C and D is recognisable mostly by the appearance of *Verrucosporites* (Knox) Pot. & Kr., and/or *Torispora* Balme and/or corresponding disappearance of *Densosporites* (Berry) Pot. & Kr.; the boundary between Westphalian D and lower Stephanian is marked usually by the appearance of *Kosankei-sporites* Bhard., and/or a large number of new *Triguitrites* spp., as well as the disappearance of *Lycospora* S., W. & B. and *Torispora*; the boundary between lower and upper Stephanian is mostly indicated by the reappearance of *Lycospora* and also, sometimes, the other Westphalian genera such as *Densosporites* as well as *Torispora* together with *Potonielsporites* and the corresponding absence of *Triguitrites* in the latter. Besides the guiding spore genera listed above for the various horizons, the nature of total spore assemblage too is held to be very important for stratigraphical considerations.--Auth.

3-3261. Desborough, George A. STRATIGRAPHIC ASPECTS OF THE CASEYVILLE GROUP IN THE VICINITY OF POMONA, JACKSON COUNTY, ILLINOIS: Illinois, State Acad. Sci., Trans., v. 53, no. 3/4, p. 157-165, 2 maps, sec., table, 1960, pub. 1961, 11 refs.

There is no evidence to substantiate the presence of a pre-Pennsylvanian channel incised into the Degonia, Clore, and Palestine formations [Mississippian] in the vicinity of Pomona.

Pre-Pennsylvanian channel development in the vicinity of Pomona is not necessarily responsible for the local absence of the Kinkaid limestone [Mississippian] and the Degonia sandstone. The absence of these formations locally is probably due to pre-Pennsylvanian faulting and subsequent erosion and weathering which reduced the local relief produced by the faulting.

The lack of considerable thickness and lithologic variation of the Lusk formation [Pennsylvanian] indicates it was locally deposited on an erosion surface of low relief.

The local maximum thickness of 420 ft. for the Caseyville group [Pennsylvanian] is as great as any thickness measured along the outcrop belt and therefore may support the concept of a southwestward regional slope during Caseyville sedimentation.--Auth, summ.

3-3262. Stott, Donald F. CRETACEOUS ROCKS IN THE REGION OF LIARD AND MACKENZIE RIVERS, NORTHWEST TERRITORIES: Canada, Geol. Survey, Bull. 63, 36 p., 7 illus., 2 col. geol. maps (in pocket), secs. (in pocket), diag., 1960, 23 refs.; abs. in English and French.

Cretaceous rocks in southwestern Northwest Territories are described and their general distribution is outlined. Lower Cretaceous rocks, all of Albian age and of marine origin, are included in the Fort St. John group which is divided into 3 formations. The Buckinghorse formation comprises basal conglomerate and sandstone and a thick succession of sideritic shale. The overlying Sikanni formation, restricted from its original definitions, contains glauconitic sandstone and siltstone. At the top, the newly defined Sully formation includes sideritic and gypsiferous shales, which are equivalent to rocks previously included by original definitions in the Sikanni formation.

Upper Cretaceous rocks are divided into the Fort Nelson, Kotaneelee, and Wapiti formations. The Fort Nelson formation, lying conformably on the Fort St. John group, is probably of Cenomanian age and consists of massive conglomerate and coarse-grained sandstone. No Turonian sediments are known in this region. The Kotaneelee formation, containing fossils of Santonian age, includes sideritic shale, some sandstone, and sandy glauconitic mudstone. The Wapiti formation contains coal, non-marine sandstone, and shale.--Auth.

3-3263. Waagé, Karl M. STRATIGRAPHY AND REFRACTORY CLAYROCKS OF THE DAKOTA GROUP ALONG THE NORTHERN FRONT RANGE, COLORADO: U.S. Geol. Survey, Bull. 1102, 154 p., 8 illus., 2 col. geol. maps (in pocket), scale 1:12,000, 13 figs., 2 tables, 1961, 38 refs.

Clayrocks of the Dakota group (Cretaceous) include variegated claystone in the Lytle formation and gray to black clay shale and minor amounts of gray claystone in the overlying South Platte formation. The latter formation has been the chief source of clayrock for the refractory-ware industry in the Denver-Golden area since the late 1860's, but most of the refractory shale in the area has been mined.

Lytle clayrock is refractory only in a thin leached zone at the South Platte contact. Although locally present throughout the northern foothills, refractory clayrock deposits in this zone are mostly too variable in thickness and quality to be commercial.

South Platte clayrocks change from kaolinitic to illitic as the formation changes from a deltaic facies in the southern part of the foothills of the northern Front Range to a dominantly marine facies in the northern part. Only the kaolinitic clayrocks have the property of refractoriness. Consequently, refractory clayrock deposits are limited to the deltaic facies, approximately to that part of the northern foothills S. of the latitude of Boulder. Principal source beds for refractory clayrock are the uppermost subdivisions of the South Platte formation; the Van Bibber shale member is the chief source, and the overlying first sandstone is a secondary source.

Much of the Van Bibber member was removed by erosion prior to the deposition of the first sandstone, which accounts for the erratic distribution of refractory clayrock within the deltaic facies.

The report deals chiefly with the detailed stratigraphy of the deltaic facies of the South Platte formation, and with the distribution of its clayrock. Refractory clayrock deposits other than those mined, or known but not available to the local industry, are at best minor potential sources of unproven commercial value.

The deltaic facies of the South Platte formation is part of an extensive area of deltaic deposits that once covered central and most of southeastern Colorado. The bulk of Colorado's refractory clayrocks occur in these deposits and most originated during a single episode of swamp formation. Extensive reserves of refractory clayrock in S.-central Colorado are the nearest supply to replace the diminishing clayrock resources in the Denver-Golden area.--Auth.

3-3264. Waters, A. C. KEECHELUS PROBLEM, CASCADE MOUNTAINS, WASHINGTON: Northwest Sci., v. 35, no. 2, p. 39-57, map, chart, May 1961, 16 refs.

Smith and Calkins defined the Keechelus andesitic series and indicated that at Naches Pass it is divisible into post-Miocene unaltered lavas and an older group of moderately altered and structurally deformed volcanic rocks of Miocene age. Later workers, without studying the Naches Pass area, extended and redefined the Keechelus series, suggested changes in its position in the geologic column, and brought forth other concepts of its stratigraphy. The result is confusion: the Keechelus andesitic series has been described as including rocks that range in age from Eocene to Recent.

This paper attempts to relate the stratigraphy of the Tertiary rocks in Mount Rainier National Park to the Keechelus andesitic series as exposed near Naches Pass. It confirms most of Smith and Calkins' basic concepts. Their upper Keechelus consists of lavas and explosive products that formed during a volcanic phase which accompanied the emplacement of the Miocene to Pliocene Snoqualmie and Tatoosh plutons. Their lower Keechelus includes the probably lower Miocene Fifes Peak formation (chiefly basalt and basaltic andesite lavas and mudflows) and the concordantly underlying Stevens Ridge formation (chiefly rhyodacite ash flows) of Mount Rainier National Park. Eocene and lower Oligocene rocks outside the Snoqualmie quadrangle, which some writers erroneously referred to Smith and Calkins' Keechelus, may correlate with the Naches formation, which lies unconformably below lower Keechelus in the Snoqualmie quadrangle, or with the Ohanapcosh formation (perhaps an equivalent of the Naches), which lies unconformably beneath the Stevens Ridge formation in Mount Rainier National Park.

The author shows in a table the probable correlations of the rocks in Mount Rainier National Park, the southern part of the Snoqualmie quadrangle, and the northern part of the Mount Aix quadrangle.

The confusion that has prevailed regarding the use of the terms upper Keechelus and lower Keechelus, however, cannot be completely resolved by returning the name Keechelus andesitic series to the rocks (and their stratigraphic equivalents) originally assigned to the series by Smith and Calkins. The author suggests that the name Keechelus andesitic series be abandoned in favor of the better defined formations the Ellensburg, Fifes Peak, and Stevens Ridge - each

of which appears to correlate with a part of the original Keechelus andesitic series. This suggestion is also in keeping with Smith and Calkins' intent, for it is clear that they anticipated that the series must ultimately be split up into 2 or more formations.--From auth., p. 39, 56.

3-3265. Simpson, George Gaylord. THE SUPERPOSED PLIOCENE PEBAS BEDS OF THE UPPER JURUA RIVER, BRAZIL: Jour. Paleontology, v. 35, no. 3, p. 620-624, fig., May 1961, 13 refs.

Berry and Maury described plants and mollusks believed by them to come from an extension of the Pliocene Pebas formation from Peru into the Brazilian Territory of Acre. The correlation is entirely unjustified. Certainly some and probably all of the fossils in question are from latest Pleistocene or, most likely, fully Holocene Oxbow fillings, and not from any widespread formation or of any earlier age.--Auth.

3-3266. Fairbairn, H. W., and others. MINERAL AND ROCK AGES AT SUDBURY-BLIND RIVER, ONTARIO: Geol. Assoc. Canada, Proc., v. 12, p. 41-66, 3 figs., 10 tables, Dec. 1960, 23 refs.

Eighty-three isotopic age analyses on biotite, K-feldspar, and whole-rock samples from 45 localities, using both K-Ar and Rb-Sr methods have been made on igneous rocks and a few metasediments in the Sudbury-Blind River area. The numbers obtained, forming an almost continuous age spectrum from 1.0 b. y. to 2.2 b. y., are correlative with widespread and repeated diastrophism in the region. Whole-rock analyses of igneous material, where available, show higher ages than coexisting minerals in most examples, and there is reason to believe that these are close approximations to the true age. There is considerable evidence, by both K-Ar and Rb-Sr methods, of orogenic events at approximately 1.0 b. y., 1.2 b. y., and 1.6 b. y.

The oldest igneous rock found thus far is the Copper Cliff "rhyolite" (2,200 m. y.), which intrudes the basal section of a thick series of conformable metasediments and volcanics SE. of Sudbury. At Quirk Lake, granite in the basement, unconformably beneath U-bearing pebble beds, is 2,050 m. y. old. As the time of U mineralization in these Huronian sediments is placed at 1,700 m. y., and gabbro which intrudes them may be older than 1,800 m. y., their deposition must have been in the age bracket 1,800-2,050 m. y.

The Ni irruptive is older than the 1.6 b. y. orogeny, but the upper limit is undetermined. As the Onwatin slate inside the basin is likewise older than 1.6 b. y., the underlying Onaping volcanics may possibly be coeval with the volcanics to the SE. as proposed by Thomson and Williams. Clearly they are not Keweenaw as heretofore believed.

An orogenic disturbance 1.2-1.3 b. y. ago is indicated independently by Rb-Sr, K-Ar, and Pb methods of analysis. The Keweenaw is represented by intrusion of olivine diabase dikes about 1,020 m. y. ago; SE. of the Grenville front the Killarney orogeny at 950 m. y. agrees approximately with numerous previous age analyses in central Ohio.--Auth.

3-3267. Erickson, G. P., and J. Laurence Kulp. POTASSIUM-ARGON MEASUREMENTS ON THE PALISADES SILL, NEW JERSEY: Geol. Soc. America, Bull., v. 72, no. 4, p. 649-652, sec., table, Apr. 1961, 9 refs.

The results of this study indicate that in some

cases Ar retentivity of certain basaltic rocks may be as high as that of biotite flakes contained in them. The Palisades sill was chosen for study as it lies within the well-defined Newark group of Upper Triassic age and contains a variety of petrologic phases. Biotite samples were prepared from the upper fine phase and whole crushed-rock samples from various levels within the sill. Ar analyses were performed by the conventional isotope-dilution technique with consideration for atmospheric contamination and Ar purification. The rock-sample K analyses were done by isotope-dilution and solid-source spectrometry. The biotite samples were analyzed by flame photometry. The Ar^{40}/K^{40} ratios obtained are considered accurate to about 3%.

A date of 190 ± 5 m.y. was obtained from analysis of the biotite. This age is presumed to be the time of intrusion of the sill, providing that the rock has not been significantly heated subsequent to its formation.

The retentivity of whole-rock samples can be calculated from the Ar^{40}/K^{40} ratio if 100% retentivity is assumed for the biotite. The fine and chilled phases appear to retain all their Ar, whereas the medium and coarse phases show retentivities of about 85%. These retentivities may be more a function of mineral composition than texture, as the coarser rocks show more secondary alteration than the fine rocks and also have more K feldspar.--V.W. Pipkin.

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See also: Geomorphology 3-3217; Stratigraphy 3-3251, 3-3253, 3-3254, 3-3258, 3-3259, 3-3260, 3-3265; Geochemistry 3-3347.

3-3268. Nichols, Rachel H., and Jeanne M. Lyons, comps. BIBLIOGRAPHY OF VERTEBRATE PALEONTOLOGY AND RELATED SUBJECTS: Soc. Vertebrate Paleontology, Bibliog. Vertebrate Paleontology, no. 15, 53 p., 1959-1960, pub. 1961.

This bibliography was made up from periodicals received by the library of the American Museum of Natural History in New York City. It is divided into 2 sections, "1959 and earlier," and "bibliography for 1960"; papers are listed alphabetically by author in each section. The first section contains about 200 items, the second section about 750.--A.C. Sangree.

3-3269. DOES LIFE EXIST IN SPACE?: Sci. News Letter, v. 79, no. 20, p. 314-315, illus., May 20, 1961.

The evidence for extraterrestrial life includes 1) discovery of reproducible cells in the Murray meteorite of 1950, 2) organically derived hydrocarbons in the Orguell meteorite of 1864, 3) statistical deduction based on the laws of probability, 4) observations of conditions on Mars and Venus, and 5) radio signals from space.--M. Russell.

3-3270. Emerson, Alfred Edwards. VESTIGIAL CHARACTERS OF TERMITES AND PROCESSES OF REGRESSIVE EVOLUTION: Evolution, v. 15, no. 2, p. 115-131, 10 figs., table, June 1961, 49 refs.

A critical evaluation is made of theories of evolutionary processes, based mainly on sociological, biological and morphological characteristics of termites. It is concluded that several different evolutionary processes are acting together, for instance adaptive evolution combined with a regression of former adaptations and with parallel evolutionary trends. Some living genera existed already in the Eocene and, although Mesozoic fossils are absent, it is thought that much of the evolutionary history of the group took place in the Mesozoic.--C. Voûte.

3-3271. Schmeck, Harold M., Jr. MILLION YEARS ADDED TO MAN'S EVOLUTION: New York Times, v. 110, no. 37,801, p. 1, col. 7, p. 57, col. 2-3, illus., July 23, 1961.

Fossil remains of a primitive tool-making man, *Zinjanthropus boisei*, found in East Africa, have been dated by the K-Ar method as 1,750,000 years old or

Pliocene. The samples tested were anorthoclase from volcanic ash located above and below the fossil find. The new age makes it easier to fit man into an evolutionary line than earlier estimates of 600,000 years for the same find.--M. Russell.

3-3272. Pijl, L. van der. ECOLOGICAL ASPECTS OF FLOWER EVOLUTION. I. PHYLETIC EVOLUTION: Evolution, v. 14, no. 4, p. 403-416, Dec. 1960, refs.

The paper deals with the ecological significance of flowers and the various relationships between insects or birds and the flowers in which they carry out cross-pollination. For earth-scientists it is interesting to note that during the Upper Jurassic or Lower Cretaceous, when the first angiosperms lived, no well-developed bees and butterflies existed yet, and that the first flowers were adapted to pollination by beetles and perhaps some flies. The beetles and flowers differentiated together in or before the Cretaceous. Several basic morphological characteristics of angiosperms might be considered as an adaptive protection of the ovules against gnawing beetle-pollinators.--C. Voûte.

3-3273. Valentine, James W. PALEOECOLOGIC MOLLUSCAN GEOGRAPHY OF THE CALIFORNIAN PLEISTOCENE: California, Univ., Pubs. Geol. Sci., v. 34, no. 7, p. 309-442, 16 figs., 33 tables, 1961, 261 refs.

Californian Pleistocene molluscan assemblages have been intensively studied previously in a few areas, chiefly near Los Angeles and San Diego. These studies show that Pleistocene molluscan distribution differed from that of today, and some workers have ascribed these differences to marine climatic changes required to explain Californian Pleistocene molluscan distribution by determining the character of molluscan assemblages over a broad area. All published records of Pleistocene mollusks from California and Pacific Baja California were reviewed, and previously unrecorded assemblages were collected and identified.

Nine characteristic Pleistocene molluscan associations are described as fossil communities on the basis of their repeated occurrence in the Pleistocene and of their resemblance to Recent molluscan associations. Each fossil community represents a fairly restricted range of habitat conditions. Most of the fossil communities contain well-defined thermal elements composed of species that are locally

extinct today in the regions of their Pleistocene occurrences. These thermal elements suggest waters cooler or warmer than normal at present in the habitats represented by their communities in the region of their fossil occurrence.

Late Pleistocene fossil communities exhibit marked lateral changes in their thermal aspects near the western Santa Monica Mountains and near Cedros Island, as cool-water elements drop out to the S. and warm-water elements to the N. Such changes in thermal elements are supplemented by other faunal changes, and thus 3 late Pleistocene molluscan provinces - here called Cayucan, Verdean, and Magdalenan, from N. to S. - may be recognized. The Cayucan and Verdean provinces are characterized by cool-water elements in exposed littoral and shallow sublittoral communities and warm-water elements in protected communities. The most southern province contains communities of warmest aspect, and the most northern province contains those of coolest aspect.

Early Pleistocene faunas studied are chiefly from Los Angeles and Ventura basins. At Los Angeles basin 2 marine climatic situations are recorded: Lomita marl faunas record a thermal situation similar to that found in the late Pleistocene Verdean province; and Timms Point silt and San Pedro sand faunas record temperatures no warmer than today in protected shallow water but cooler than today in exposed shallow or moderately deep water. At Ventura basin the faunal succession is not well known, but recorded assemblages contain temperate protected-shore and cool exposed-shore communities. Ventura basin faunas thus appear to be rather monotonous thermally. It seems likely that an early Pleistocene provincial boundary analogous to the Cayucan-Verdean boundary lay chiefly S. of Ventura basin. Probably it moved S. of Los Angeles basin during the deposition of the Timms Point silt and San Pedro sand.

Changes in the marine climatic regime which might account for the observed faunal changes may well be related to Pleistocene glaciation. If so, the late Pleistocene thermal situation revealed by the molluscan assemblages, as well as that represented by the lower Pleistocene Lomita marl, appears to be adglacial. By contrast, the Timms Point silt and San Pedro sand appear to be deglacial.--Auth.

3-3274. Dubar, Jules R., and Donald W. Beardsley. PALEOECOLOGY OF THE CHOCTAWHATCHEE DEPOSITS (LATE MIOCENE) AT ALUM BLUFF, FLORIDA: Southeastern Geology, v. 2, no. 3, p. 155-189, 2 figs., 2 tables, March 1961, 40 refs.

The Choctawhatchee (late Miocene) deposits exposed at Alum Bluff, Liberty County, are described. The development of facies within the Choctawhatchee is much more complex than indicated by Puri. It is suggested that the full significance of these facies and their interrelationship will not be understood until all exposures are studied in much more detail and until more subsurface data become available.

The terminology previously applied to the Choctawhatchee deposits of western Florida is critically discussed. Classification of facies should be genetic, or where such a classification is not feasible, facies should be named according to the dominant lithology.

Comparison of fossil molluscan and foraminiferal assemblages with extant communities in the Gulf of Mexico, western Atlantic, and Caribbean offers strong evidence that the Alum Bluff Choctawhatchee sediments were deposited in the inner neritic zone in less than 8 fathoms of water. This conclusion is sub-

stantiated by stratigraphic, lithologic, and paleogeographic observations.

The lower Choctawhatchee shell bed at Alum Bluff was deposited in normal open shelf marine water during a minor transgression of the sea, and the upper beds were laid down during the succeeding regression under brackish-water and terrestrial conditions.--Auth.

3-3275. Finks, Robert M. and others. STRATIGRAPHIC IMPLICATIONS OF A PERMIAN SPONGE OCCURRENCE IN THE PARK CITY FORMATION OF WESTERN WYOMING: Jour. Paleontology, v. 35, no. 3, p. 564-568, 3 figs., May 1961, 11 refs.

The lithistid sponge *Actinocoelia maeandrina* Finks has been found recently in abundance in the Franson member of the Park City formation near Dubois, Wyoming. This new occurrence extends the range of the species from W. Texas, southern New Mexico, northern Arizona, and southern Nevada to western Wyoming. All previous occurrences are from rocks datable as late Leonard or early Guadalupe (Brushy Canyon). The new occurrence suggests that the Franson member in this area is late Leonard or early Guadalupe age. Stratigraphic and paleontologic evidence indicates that the sponge is essentially confined to deposits made in shallow, clear water of normal marine salinity with an abundant shelly fauna. It is likely that this sponge can be used as an index to the upper Leonard to lowermost Guadalupe interval throughout the Cordilleran area, and as an indicator of a shelf or a shell-bank environment.--Auth.

3-3276. Stumm, Erwin C., and J. Lloyd Watkins. THE METRIOPHYLLOID CORAL GENERA STEREO-LASMA, AMPLEXIPHYLLUM, AND STEWARTOPHYLLUM FROM THE DEVONIAN HAMILTON GROUP OF NEW YORK: Jour. Paleontology, v. 35, no. 3, p. 445-447, pl., May 1961, 7 refs.

Daniel Busch described 6 new species of metriophylloid rugose corals from the Wanakah and Windom shales of the Hamilton group of western New York. After an examination of many serial sections of specimens from these beds it is suggested that Busch's species can be interpreted as growth stages or variants of the 3 common species *Stereolasma rectum* (Hall), *Amplexiphyllum hamiltoniae* (Hall), and *Stewartophyllum intermittens* (Hall).--Auth.

3-3277. Durham, J. Wyatt. MIOCENE ECHINOIDS FROM THE VALLE CENTRAL, COSTA RICA: Jour. Paleontology, v. 35, no. 3, p. 480-488, 2 figs., 2 pls., May 1961, 15 refs.

Echinolampas woodringi n. sp., *Pericosmus is-raelskyi* n. sp., *Schizaster costaricensis* n. sp., *Schizobrissus kewi* n. sp., *Plagiobrissus costaricensis* n. sp., and *P. malavassii* n. sp. are described. *Brissopsis* n. sp., and *Clypeaster* sp. indet. are recorded and figured. It is concluded that the echinoids probably lived in water between 100 and 300 m. deep. Most of these echinoids have their closest relatives in the Mesón and Tuxpan formations of Mexico and the Ojo de Agua formation of Venezuela.--Auth.

3-3278. Stehli, Francis G. NEW GENERA OF UPPER PALEOZOIC TEREBRATULOIDS: Jour. Paleontology, v. 35, no. 3, p. 457-466, 8 figs., pl., May 1961, 7 refs.

Six new genera of terebratuloid brachiopods from

Mississippian and Permian strata are described and figured. The new genera are *Gacina* with *G. cooperi*, n. sp., as genotype, *Afilasma* with *A. beecheri*, n. sp., as genotype, *Lowenstamia* with *L. texana*, n. sp., as genotype, *Pakistania* with *Dielasma biplex* Waagen as genotype, *Alwynia* with *Dielasma vesiculare* de Koninck as genotype, and *Timorina* with *Notothyris minuta* Broili (non Waagen) as genotype. All of the available information regarding the internal characteristics of these forms is considered, and diagrammatic reconstructions and idealized serial sections are presented.--Auth.

3-3279. Stehli, Francis G. NEW TEREBRATULOID GENERA FROM AUSTRALIA: Jour. Paleontology, v. 35, no. 3, p. 451-456, 4 figs., pl., May 1961, 5 refs.

Three new genera of terebratuloid brachipods from the Permian of Australia have been recognized. These genera are here described as *Gilledia* with *Terebratula cymbaeformis* Morris 1845 as genotype, *Fletcherina* with *Terebratula amygdala* Dana 1847 as genotype, and *Yochelsonia* with a new species *Y. thomasi* as genotype. This investigation has included study of the internal structures of these forms, and both serial sections and reconstructions of internal structures are provided.--Auth.

3-3280. Fagerstrom, John A. BUSYCON (BUSYCON) TRITONE CONRAD REDESCRIBED AND REILLUSTRATED: Jour. Paleontology, v. 35, no. 3, p. 448-450, 2 pls., May 1961, 10 refs.

The previous literature pertaining to *Busycon* (*Busycon*) tritone Conrad is briefly reviewed, and the species is redescribed and reillustrated on the basis of a well preserved topotype.--Auth.

3-3281. Flower, Rousseau H. MAJOR DIVISIONS OF THE CEPHALOPODA: Jour. Paleontology, v. 35, no. 3, p. 569-574, May 1961, 5 refs.

Division of the Cephalopoda into Tetrabranchiata and Dibranchiata involves implications as to the nature of unknown soft parts of fossil forms. Factual and theoretical evidence combine to suggest that many of the features of the Dibranchiata may have developed in their ancestors included in the Nautiloidea, and that many of the features of Nautilus are derived, possibly connected with crucial changes in mode of life now known to have occurred in its ancestry.

Use of similar divisions to separate forms with external versus internal shells also involves inferences; recent work has shown this boundary one difficult to draw in relation to primitive belemnites and some supposed bacitritids.

It is urged that the tripartite divisions of the Cephalopoda into Nautiloidea, Coleoidea, and Ammonoidea is in closer accord with ascertainable facts and avoids attributing some 3,000 extinct genera to a group characterized by the 4 gills observable only in 1 genus, the living *Nautilus*.--Auth.

3-3282. Palmer, Katherine Van Winkle. A NEW NAUTILOID, EUTREPHOCERAS EYERDAMI, NEW SPECIES FROM THE COWLITZ FORMATION, UPPER EOCENE, OF WASHINGTON: Jour. Paleontology, v. 35, no. 3, p. 532-534, pl., May 1961, 26 refs.

Eutrephoceras eyerdami Palmer, n. sp., is described from the Cowlitz formation, upper Eocene of

Washington. Although fragments of *Eutrephoceras* have been reported from the locality the present shell is the first to be preserved well enough for specific naming. The specimen was found by Walter J. Eyerdam at the type locality of the Cowlitz formation, on the Cowlitz River, near Vader, Lewis County, Washington.--Auth.

3-3283. Imlay, Ralph W. NEW GENERA AND SUB-GENERA OF JURASSIC (BAJOCIAN) AMMONITES FROM ALASKA: Jour. Paleontology, v. 35, no. 3, p. 467-474, 2 pls., May 1961, 16 refs.

New genera and species of Bajocian [Middle Jurassic] ammonites from Alaska include *Megasphaeroceras rotundum* Imlay, *Determanites vigorosus* Imlay, and *Parabigotites crassicosatus* Imlay. A new subgenus and species is *Oppelia* (*Liroxyites*) *kellumi* Imlay. Of these *Megasphaeroceras*, *Determanites*, and *Oppelia* (*Liroxyites*) are associated with *Sphaeroceras*? *Leptosphinctes*, and *Sphaeroceras* of late Bajocian age. *Parabigotites* is associated with *Stephanoceras*, *Ootites*, *Sonninia*, *Witchellia*, and *Lissoceras* of middle Bajocian age.--Auth.

3-3284. Jones, David L. MUSCLE ATTACHMENT IMPRESSIONS IN A CRETACEOUS AMMONITE: Jour. Paleontology, v. 35, no. 3, p. 502-504, pl., May 1961, 6 refs.

Muscle attachment impressions in an Upper Cretaceous ammonite, *Diplomoceras notabile* Whiteaves consist of a pair of bean-shaped retractor muscle impressions on the dorsal (antisiphonal) side, and a single, nearly round, impression on the venter, the origin and function of which is not known.

The muscular attachment system in *D. notabile* appears to differ from the typical nautiloid attachment system in lacking a continuous annular elevation and in having a single ventral attachment impression.--Auth.

3-3285. Jeletzky, J. A. ACTINOCAMAX FROM THE UPPER CRETACEOUS BENTON AND NIOBRARA FORMATIONS OF KANSAS: Jour. Paleontology, v. 35, no. 3, p. 505-531, 6 figs., pl., table, May 1961, 22 refs.

The following forms of *Actinocamax* are described and figured from the Upper Cretaceous Benton and Niobrara formations of Kansas: *A. manitobensis* (Whiteaves) f. typ., *A. manitobensis* var. *kansasus* n. var., *A. cf. manitobensis* var. *spicularis* n. var., *A. sternbergi* n. sp., *A. Walkeri* n. sp., *Actinocamax* sp. aff. *A. laevigatus* Arkhangelsky, *Actinocamax* sp. indet. *A.* (? aff. *A. manitobensis* Whiteaves). The belemnite material studied includes all Niobrara belemnites recently described by Miller as *Belemnites praecursor* Stolley. These belemnites are revised and placed in the genus *Actinocamax* s. str.

The described *Actinocamax* forms from Kansas range from late Turonian to the late Santonian or early Campanian age. The Coniacian to (?)early Campanian *Actinocamax* forms are closely allied to the W. Greenland *Actinocamax* faunas recently described by Birkelund. The late Turonian *Actinocamax* fauna is identical with the *A. manitobensis* fauna from Manitoba. The previously informally described Canadian *Actinocamax* sp. aff. *A. strehlensis* Fritsch and Schloenbach is revised in connection with the description of the Kansas *Actinocamax*; it is assigned to the species *A. manitobensis* as its new variety (var. *spicularis* n. var.).

The alveolar and apical ends of several *Actinocamax* forms from Kansas are deformed so as to indicate that they were sufficiently soft and pliable to be squashed or bent by the pressure of sediment after the burial of the guards.--Auth.

3-3286. DuBar, Jules R., and James R. Solliday. CHECK LIST OF DUPLIN (LATE MIOCENE) MOLLUSCAN SPECIES OF GEORGIA AND THE CAROLINAS: South Carolina, State Geol. Board, Div. Geology, Geol. Notes, v. 5, no. 2, p. 15-30, March-Apr. 1961, 12 refs.

Late Miocene marine deposits of Georgia, South Carolina, and North Carolina generally are considered to compose the Duplin formation. Deposits in Florida, possibly contemporaneous with the Duplin, are termed the Choctawhatchee formation in the Panhandle and the Tamiami formation in southern Florida. In northern North Carolina, Virginia, and southern Maryland, late Miocene marine deposits are referred to the Yorktown formation which is thought to be, at least in part, equivalent to the Duplin formation. Actually, the precise stratigraphic relationship among these 4 formations has not been determined.

Preliminary to a detailed stratigraphic-paleoecologic study of the Duplin formation, the authors compiled a check list of Duplin molluscan species that have been reported in the literature from Georgia and the Carolinas. Previously, the most comprehensive list of Duplin mollusks was published by Dall. Since that time many additional species have been reported from various paleontologists. The present authors have attempted to eliminate the obvious synonyms and to bring the nomenclature up-to-date.

In preparation of the check list only those localities were considered which, on the basis of the fauna and other published stratigraphic data, appear to clearly represent equivalent deposits of late Miocene age (Duplin formation).

Supplementary to study of the literature, the authors made and examined large collections from the type locality of the Duplin formation at Natural Well, near Magnolia, North Carolina, and from the N. bank of Lake Waccamaw, Columbus County, North Carolina.

The check list includes 238 species and subspecies of pelecypods, 357 species and subspecies of gastropods, 7 species and subspecies of scaphopods, and 1 amphineurid species; a total of 603 species and subspecies.--Auth.

3-3287. Silberling, Norman J. UPPER TRIASSIC MARINE MOLLUSKS FROM THE NATCHEZ PASS FORMATION IN NORTHWESTERN NEVADA: Jour. Paleontology, v. 35, no. 3, p. 535-542, 2 figs., pl., May 1961, 14 refs.

Diagnostic ammonites and other fossils indicate that much of the Natchez Pass formation in northwestern Nevada is of early Late Triassic (Karnian) age instead of Middle Triassic age as originally dated. *Trachyceras*, sensu stricto, of early Karnian age occurs in the lower part of the Natchez Pass formation in the East Range and is tentatively identified from a corresponding stratigraphic position in the Humboldt Range. The upper part of the formation in the northeastern foothills of the Humboldt Range has yielded a large upper Karnian fauna including *Paratropites* cf. *P. sulcatus* (Calcara), *Spirogonoceras shastense* (Smith), *Pleuromutilus?* *alaskensis* Kummel, and *Septocardia?* sp., which are described in this paper.--Auth.

3-3288. Menzies, Robert J., and Donald J. Robinson. RECOVERY OF THE LIVING FOSSIL MOLLUSK, NEOPILINA, FROM THE SLOPE OF THE CEDROS TRENCH, MEXICO: Science, v. 134, no. 3475, p. 338-339, illus., Aug. 4, 1961, 2 refs.

Fourteen small monoplacophoran mollusks, relict animals with a discontinuous geologic range between the Paleozoic and the Recent, have been recovered from a sample taken Dec. 31, 1960, from the slope of the Cedros trench, Baja California. This collection represents the most northern record for the Monoplacophora as well as the largest single collection.

Exact assignment of the specimens to 1 of the 2 known species remains uncertain. This uncertainty is due to the fact that the specimens are apparently different in shell sculpture from both *Neopilina* (*Neopilina*) *galathea* Lemche and *Neopilina* (*Vema*) *ewingi* Clarke and Menzies.--From auth.

3-3289. Whittington, Harry B. SILURIAN HEMIARGES (TRIOBITA) FROM CORNWALLIS ISLAND AND NEW YORK STATE: Jour. Paleontology, v. 35, no. 3, p. 433-444, 3 pls., May 1961, 13 refs.

Neither of the 2 new species from the Upper Silurian of Cornwallis Island, Northwest Territories, Canada, is represented by a complete specimen, but the disarticulated material of one is silicified. The morphology of the holaspis exoskeleton is revealed in detail and the development from the late meraspis onward. The second species lacks marginal spines on larger pygidia. Both species are like *H. ptyonurus* from the Upper Silurian of New York State, the original material of which is redescribed. The 3 species belong to a group of *Hemiarges* species differing in some respects from the type and like species. The distinctive characters of the exoskeleton are combined in so many different ways in *Hemiarges* species, however, that subdivisions of the genus are not now practicable.--Auth.

3-3290. Bardack, David. NEW TERTIARY TELEOSTS FROM ARGENTINA: Am. Mus. Nat. History, Am. Mus. Novitates, no. 2041, 27 p., 7 figs., July 1961.

Our knowledge of the Tertiary fresh-water fishes of South America has been confined largely to the few forms described from several lacustrine deposits in Brazil. This assemblage, probably of late Tertiary age, is composed of a clupeid (*Knightia*), at least 3 characins (*Procharax*, *Lignobrycon*, and *Eobrycon*), an ariid (*Arius*), a serranid (*Percichthys*), and 3 cichlids (*Acara*, *Aequidens*, and *Macracara*). In addition, a *Percichthys* is recorded from the Eocene of Argentina. Several siluroid and lepidosirenid fragments have been described from various localities in South America.

Austroclupea zuninoi (Clupeidae), *Corydoras revelatus* (Callichthyidae), *Aequidens saltensis*, and *Acaronia longirostrum* (Cichlidae) are described from Salta province in Argentina. The *Corydoras* comes from the Margas Multicolores, a stratigraphic unit of middle Tertiary age as determined by incomplete mammalian and chelonian material. The 3 other genera are from the Terciario Subandino, a unit dated as late Tertiary by the Argentinian oil company, Yacimientos Petroliferos Fiscales. The fishes themselves, as well as associated fragmentary invertebrate material, indicate a fresh-water origin of both deposits.

All of the South American Tertiary teleost deposits are discussed. The approximate age of each deposit is given. Most of the fossil teleosts are shown to occur within the same geographic area as related modern forms. Fossil evidence pertaining to the origin of the South American fish fauna is still lacking. However, the gradually increasing fossil record may make it possible to determine the evolution of certain groups once established in South America.--Auth.

3-3291. Schaeffer, Bobb, and Joseph T. Gregory. COELACANTH FISHES FROM THE CONTINENTAL TRIASSIC OF THE WESTERN UNITED STATES: *Am. Mus. Nat. History, Am. Mus. Novitates*, no. 2036, 18 p., 6 figs., July 1961.

Coelacanth remains occur in both the lower and the upper Triassic continental beds of the western United States. *Moenkopia wellesi* new genus and species, is described from the Moenkopi formation on the basis of basisphenoid characters. Specimens from the Dockum and Chinle formations are at present too incomplete for taxonomic allocation. Comparison of the basisphenoid in various coelacanth genera indicates that this element has considerable diagnostic value.--B. Schaeffer.

3-3292. Warren, James W. THE BASICRANIAL ARTICULATION OF THE EARLY PERMIAN COTYLOSAUR, CAPTORHINUS: *Jour. Paleontology*, v. 35, no. 3, p. 561-563, 2 figs., May 1961, 6 refs.

Excellent preserved specimens of *Captorhinus* sp. show the pterygoid to be completely excluded from the cranio-palatal articulation. This is interpreted to be the primitive condition which was modified in later reptiles.

Teeth are described for the first time from the vomer, palatine, and parasphenoid bones of *Captorhinus* sp.--Auth.

3-3293. Brattstrom, Bayard H. SOME NEW FOSSIL TORTOISES FROM WESTERN NORTH AMERICA WITH REMARKS ON THE ZOOGEOGRAPHY AND PALEOECOLOGY OF TORTOISES: *Jour. Paleontology*, v. 35, no. 3, p. 543-560, 10 figs., table, May 1961, 62 refs.

The discovery of several fossil tortoises contribute significantly to our understanding of tortoise distribution in western North America. These include: *Gopherus neglectus*, n. sp. from the Oligocene part of the Sespe formation, California; *Testudo milleri*, n. sp. from the Barstow Miocene of California; and *Gopherus depressus*, n. sp. from the Tehachapi Miocene of California. New material of previously known fossil tortoises is described.

A technique for the determination of past climates by the use of fossil reptiles and amphibians and the temperature requirements of modern reptiles and amphibians assumes that the animals have not greatly changed their ecological requirements in the course of their evolution. One chance to test this assumption in one group of reptiles is afforded by the proximity (stratigraphically and geographically) of fossil plant and fossil tortoise sites. Some of the zoogeographic implications of the paleoecological data are discussed.--Auth.

3-3294. Ostrom, John H. CRANIAL MORPHOLOGY OF THE HADROSAURIAN DINOSAURS OF NORTH

AMERICA: *Am. Mus. Nat. History, Bull.*, v. 122, art. 2, p. 33-186, 78 figs., 6 pls., June 1961.

The results of a study including a majority of existing hadrosaurian skulls from North America are presented. Included are discussions of cranial myology, neurology, and certain vascular elements in addition to the usual osteological analysis. Emphasis is placed on cranial mechanics and functional anatomy. Well preserved muscle scars make possible a nearly complete restoration of the mandibular musculature, and evidence is presented indicating that the M. pterygoideus and M. adductor posterior functioned as mandibular protractors and retractors rather than as adductors. The cervical axial muscles are partially reconstructed. Endocranial casts provide a detailed restoration of the hadrosaurian brain and cranial nerves. Using *Corythosaurus casuarius* as the principal example, the hadrosaurian skull is shown to have been akinetic and monimostylic. The latter condition is correlated with mandible retraction and protraction, increasing the efficiency of the rodentlike mastication activities of the large dental batteries. Phylogenetic considerations indicate an early (mid-Cretaceous) divergence of 3 distinct phyletic lines derived from an unknown campylosaurid-like stock. These lineages are given taxonomic recognition in 3 subfamilies: Hadrosaurinae (noncrested species), Lambeosaurinae (true narial crested species), and Saurolophinae (pseudo-narial crested species). The true narial crests are correlated with olfaction and not with air storage or water exclusion.--Auth.

3-3295. Ostrom, John H. A NEW SPECIES OF HADROSAURIAN DINOSAUR FROM THE CRETACEOUS OF NEW MEXICO: *Jour. Paleontology*, v. 35, no. 3, p. 575-577, fig., May 1961, 3 refs.

A new species of *Parasaurolophus*, *P. cyrtocris-tatus*, is recorded from the Fruitland formation of the San Juan basin, New Mexico.--Auth.

3-3296. Miller, Loye, and others. NEW LIGHT ON THE FLIGHTLESS GOOSE *CHENDYTES LAWI*: Los Angeles County Mus., *Contr. Sci.* no. 43, p. 1-11, 2 pls., June 1961.

A skull, associated vertebrae, pectoral and pelvic elements, and the humerus of *Chendytes lawi* have been collected on Anacapa Island, California, and are described. Suggestions as to feeding habits are made.

These fossiliferous sediments on Anacapa Island are tentatively thought to be equivalent to the Garanon member of the Santa Rosa Island formation.--J. A. White.

3-3297. Clemens, William A. A LATE CRETACEOUS MAMMAL FROM DRAGON CANYON, UTAH: *Jour. Paleontology*, v. 35, no. 3, p. 578-579, fig., May 1961, 3 refs.

An upper molar of *Pediomys hatcheri* (Osborn), probably derived from the "Cretaceous portion" of the North Horn formation, was discovered in Dragon Canyon, Utah.--Auth.

3-3298. Stokes, William Lee, and Kent C. Condie. PLEISTOCENE BIGHORN SHEEP FROM THE GREAT BASIN: *Jour. Paleontology*, v. 35, no. 3, p. 598-609, 7 figs., 4 tables, May 1961, 19 refs.

Partial skulls of 15 bighorn sheep mostly from

Pleistocene lake deposits near Salt Lake City have been measured and compared with living forms from North America and the Old World. The Great Basin specimens all belong to one species and are referred to *Ovis catchlawensis*, Hibbard and Wright, previously known only from a fragmentary jaw from Mohave County, Arizona. *Ovis catchlawensis* resembles *Ovis* ammon from the High-Asian plateaus more than it does the living North American species, *Ovis canadensis*. Details of bighorn migrations between North America and Eurasia are not yet fully understood.--Auth.

3-3299. McKenna, Malcolm C. A NOTE ON THE ORIGIN OF RODENTS: Am. Mus. Nat. History, Am. Mus. Novitates, no. 2037, 5 p., fig., July 1961.

The only known upper cheek tooth of the earliest known rodent, *Paramys atavus*, is described. The immediate ancestry of rodents would seem to trace to an animal in the process of minimizing the buccal cingulum and developing a small hypcone at the lingual end of a posterior cingulum, probably a Paleocene primate or primate-like insectivore. It is probably not necessary to seek for the immediate ancestors of rodents in pre-Paleocene sediments.--Auth.

3-3300. White, John A., and Theodore Downs. A NEW GEOMYS FROM THE VALLECITO CREEK PLEISTOCENE OF CALIFORNIA, WITH NOTES ON VARIATION IN RECENT AND FOSSIL SPECIES: Los Angeles County Mus., Contr. Sci. no. 42, p. 1-34, 17 figs., 8 tables, June 1961

A new species of extinct *Geomys* (*G. garbanii*) is described from the western Imperial Valley of southern California, and extensive data are presented on intraspecific variation in Recent and fossil species.

The presence of such characters as opisthodont upper incisors, deep rostrum, enlarged auditory bullae, and large external auditory meatus, is thought to indicate a primitive condition showing closer relationship to the heteromyids than to any other *Geomys*. Other characters of *G. garbanii* also are deemed to be primitive, but their relationships are subtle, for they occur in adult specimens of the fossil species and in juvenile specimens of Recent species. *G. quinni* from the Sand Draw (Blancan) local fauna of Nebraska also has primitive characters that are present in *G. garbanii*.

G. parvidens from the Conard Fissure fauna of Arkansas is placed as a subspecies under *G. bur-sarius* as *G. b. parvidens*.

Zygogeomys which occurs in a restricted area in Mexico is considered to be a relict genus possibly representing the modern survival of *G. garbanii* as a structural type.

G. garbanii has been collected throughout nearly 2,500 ft. of section in the upper part of the Palm Spring formation, yet no apparent difference exists between specimens taken from higher or lower portions of the section.

Paleoecologically, the presence of *G. garbanii* in the Vallecito Creek fauna indicates some type of grasslands and a moderate, average annual precipitation.--Auth.

3-3301. Black, Craig C. A SECOND RECORD OF THE FOSSIL RODENT *PALUSTRIMUS* WOOD: Breviora, no. 131, p. 1-3, illus., Dec. 1960, 2 refs.

Attention is drawn to a new early Miocene fossil

locality 6 mi. WNW. of Fort Laramie National Monument, Wyoming, at which the following vertebrate genera occur: *Prosciurus*, *Promylagaulus*, *Heliscomys*, *Palustrimus*, and *Palaeocastor*. The occurrence of a *Palustrimus* tooth, here described, is particularly important as the type specimen has been lost since 1950.--M. Russell.

3-3302. Graham, Joseph J. AN ANNOTATED BIBLIOGRAPHY OF CALIFORNIA CRETACEOUS MICROFOSSILS, INCLUDING A BRIEF HISTORY OF THE LITERATURE: California, Div. Mines, Spec. Rept. 66, 43 p., 1961.

It is hoped that this bibliography - covering 180 references - adequately summarizes the vast amount of research that has already been published on the micropaleontology of the Cretaceous system in California and will be of some aid in suggesting problems that will add to our understanding of this portion of the geologic column. Few papers are included that give the synonymies of the various species; other bibliographies, such as those by Hans E. Thalmann, cover this field to some extent, and the taxa listed therein should supply the systematist with the necessary information.--From auth. p. 7.

References are listed chronologically, covering the years 1891 through 1960.

3-3303. Loeblich, Alfred R., Jr., and Helen Tappan. THE GENERA *MICROAULOPORA* KUNTZ, 1895, AND *GUEMBELINA* KUNTZ, 1895, AND THE STATUS OF *GUEMBELINA* EGGER, 1899: Jour. Paleontology. v. 35, no. 3, p. 625-627, fig., May 1961, 10 refs.

The Paleozoic chitinous micro-organisms *Microaulopora* Kuntz, 1895, and *Guembelina* Kuntz 1895, are discussed on the basis of the original figures and descriptions. *Guembelina* Egger, 1899 (Foraminifera), recently shown to be a junior synonym of *Heterohelix* Ehrenberg, 1841, is thus doubly invalidated, in being also a junior homonym of *Guembelina* Kuntz, 1895.--Auth.

3-3304. Hornaday, Gordon R. FORAMINIFERA FROM THE SACATE FORMATION SOUTH OF REFUGIO PASS, SANTA BARBARA COUNTY, CALIFORNIA: California, Univ., Pubs. Geol. Sci., v. 37, no. 3, p. 165-232, 6 figs., 13 pls., 1961, 76 refs.

The Sacate formation as exposed in Cañada del Refugio has been divided into a lower member and an upper member. Eighty species of Foraminifera obtained from 35 samples collected from the 1,075 ft. of fine-grained clastic sediments that constitute the upper member are recorded. One new species and 3 new varieties are described.

The sequence of zonules and faunules indicates that deposition of the lower part of the upper member of the Sacate took place in moderately deep water (middle or lower bathyal). Subsequently, a progressive but gradual shallowing took place, so that the uppermost strata of this unit were deposited in the neritic zone. An influx of cooler-water elements was associated with the shoaling reflected in the upper part of this unit.

The upper member of the Sacate formation at Cañada del Refugio falls within Mallory's Narizian stage, and most of the member, possibly all of it, is restricted to the *Amphimorphina jenkinsi* zone. It is thus late Eocene in age and may be correlated, in part, with such formations as the Kreyenhagen, the Tejon, and

the Sidney shale member of the Markley, in California; the Toledo, the lower Basterdorf, and the Cowlitz, in the Pacific Northwest; the Jackson, on the Gulf Coast; the Chira shale, in Peru.--Auth.

3-3305. Obregón de la Parra, Jorge. FORAMINIFEROS DE LA FORMACION LA PEÑA [Foraminifera from the La Peña Formation]; Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 3/4, p. 135-153, map, chart, sec., 5 pls., Mar.-Apr. 1959; text in Spanish.

A preliminary report describing the Foraminifera from a measured section of the La Peña formation (Cretaceous, Albian) in the Sierra de Sabinas-Lampazos, northern Nuevo León. The fauna consists of 12 families, 26 genera, and 38 species (20 new, 18 representing new stratigraphic or geographic occurrences), on the basis of which the formation is divided into 8 faunizones and 5 teilzones. The lithologic characteristics of the formation in all outcrops in northeastern Mexico are so similar that environmental conditions of deposition must have been very uniform. The preponderance of pelagic Foraminifera belonging to the families Globigerinidae and Hantkeninidae would suggest deposition in a sea of relatively deep waters. However, the thanatocoenosis is mixed. The pelagic forms show an evident dwarfism, and the presence of fine, dark mud, possibly the product of soils from areas of land which emerged contemporaneously or in the pre-upper Albian, indicate a sublittoral deposition within the continental platform, with a depth variable between 50 and 200 m. Most of the Foraminifera found at this locality also occur in the Otates formation of the Tampico sedimentary basin.--A.M. Gutstadt.

3-3306. Eternod Olvera, Yvette. FORAMINIFEROS DEL CRETACICO SUPERIOR DE LA CUENCA DE TAMPICO-TUXPAN, MEXICO [Foraminifera from the Upper Cretaceous of Tampico-Tuxpan Basin, Mexico]; Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 3/4, p. 63-134, map, 9 pls., Mar.-Apr. 1959, 130 refs.; text in Spanish.

Foraminifera from cores of the Méndez formation (Campan-Maestrichtian) are described and figured. Forty-seven species (7 new), 1 subspecies (new), and 3 varieties are included, some representing genera not previously identified from the Upper Cretaceous of Mexico. Most of the forms studied were meroplanktonic.--A.M. Gutstadt.

3-3307. Malavassi Vargas, Enrique. SOME COSTA RICAN LARGER FORAMINIFERAL LOCALITIES; Jour. Paleontology, v. 35, no. 3, p. 498-501, map, table, May 1961, 18 refs.

Nineteen species of larger Foraminifera, of which 2 species are from the Upper Cretaceous, 1 from the middle Eocene, 11 from the upper Eocene, and 4 from the upper Oligocene, are recorded from 10 Costa Rican localities. These faunas are correlated with other well known Caribbean localities.--Auth.

3-3308. Douglass, Raymond C. ORBITOLINAS FROM CARIBBEAN ISLANDS; Jour. Paleontology, v. 35, no. 3, p. 475-479, 5 maps, 2 pls., May 1961, 6

refs.

The foraminiferal genus *Orbitolina* is recognized in the Dominican Republic, Puerto Rico, Barbados, and Trinidad. The species present indicate an Albian (Early Cretaceous) age. *Orbitolinoides senni* Vaughn is recognized as a species of *Orbitolina*.--Auth.

3-3309. Gordon, W. A. DISTRIBUTION OF FORAMINIFERA IN THE MIDDLE TERTIARY SAN SEBASTIAN-ISABELA SECTION, PUERTO RICO; Caribbean Jour. of Sci., v. 1, no. 2, p. 48-58, 3 tables, May 1961, 15 refs.

The stratigraphic distribution of 127 species of Foraminifera in the San Sebastián-Isabela section is recorded in tabular form, and the paleocologic significance of the data presented is briefly discussed. It is concluded that most of the middle Tertiary in the section was accumulated in shallow water, with a deeper water phase at the end. The distinctive nature of the Puerto Rican foraminiferal faunas is noted.--Auth.

3-3310. Gordon, W. A. MIOCENE FORAMINIFERA FROM THE LAJAS VALLEY, SOUTHWEST PUERTO RICO; Jour. Paleontology, v. 35, no. 3, p. 610-619, 2 figs., May 1961, 28 refs.

Fossils are recorded for the first time from a limestone in the Lajas Valley of SW. Puerto Rico. Twenty-three species of Foraminifera are listed, and the other elements of the fauna are also recorded. Two foraminiferal species are new, *Pyrgo opima* and *Dendritina lajasensis*. It is concluded that the fauna is Miocene in age.--Auth.

3-3311. Kesling, Robert V. MIDDLE ORDOVICIAN BLACK RIVER OSTRACODS FROM MICHIGAN. PART III, PLATYBOLBINA; Michigan, Univ., Mus. Paleontology, Contr., v. 15, no. 16, p. 365-385, 8 pls., 2 tables, Dec. 12, 1960, 23 refs.

Six new species of paleocopan ostracods are described from unit 4 of the Middle Ordovician Bony Falls limestone at Bony Falls, Michigan. They are *Platylbolbina chalazia*, *P. compsa*, *P. dictyora*, *P. omphalata*, *P. psedna*, and *P. schadidea*.--M. Russell.

3-3312. Woodring, W. P., and Enrique Malavassi Vargas. MIOCENE FORAMINIFERA, MOLLUSKS, AND A BARNACLE FROM THE VALLE CENTRAL, COSTA RICA; Jour. Paleontology, v. 35, no. 3, p. 489-497, map, 2 pls., May 1961, 26 refs.

For many years middle Tertiary fossils have been known to occur in the Valle Central of Costa Rica. Siltstone at a locality near Turrúcares, 25 km. W. of San José and at an altitude of 640 m. above sea level, recently yielded Foraminifera. Mollusks, a barnacle, and echinoids were found in sandstone conformably overlying the siltstone. The Foraminifera are listed, and the mollusks and barnacle are briefly described. These fossils are of Miocene age. The Foraminifera suggest middle Miocene; the mollusks indicate early or middle Miocene.--Auth.

6. GEOPHYSICS

3-3313. Ahrens, L.H., and others, eds. **PHYSICS AND CHEMISTRY OF THE EARTH.** [VOL.] 4: 317 p., illus., maps, diags., tables, New York, Pergamon Press, 1961, refs.

The fourth and most recent volume in this series. Vol. 3 was listed as GeoScience Abstracts 2-1163. A principal aim of the series is to provide authoritative and up-to-date surveys of progress for those actively engaged in geophysics and geochemistry. It is hoped also that much of what is written will encourage the interest of the chemist and physicist in a study of our planet, not merely for its own sake, but because such a study often turns out to be of benefit to physics and chemistry. Another aim is to acquaint the geologist with the results and methods of geophysics and geochemistry, particularly as progress in earth science has been hindered by some lack of liaison between different groups. The subject matter coming under the heading of physics and chemistry of the earth is vast, and only a limited number of topics can be considered in a given volume; in general, an attempt will be made to provide a balanced variety of topics with roughly equal emphasis on chemistry and physics.--From pref. to Vol. 1.

The 8 papers in Vol. 4 are listed below:

- Solar and Stellar Abundances of the Elements, by Lawrence H. Aller.
- The Origin of the Main Geomagnetic Field, by R. Hide and P.H. Roberts.
- Eustatic Changes in Sea Level, by Rhodes W. Fairbridge.
- Variations of the Earth's Rotation, by Sir Harold Spencer Jones.
- On Determination of Earthquake Mechanism, by L. M. Balakina, and others.
- The Oscillations of the Earth, by Robert Stoneley.
- The Theory of Nutation and the Internal Constitution of the Earth, by R.O. Vicente.
- Chemical and Mineralogical Aspects of Deep-Sea Sediments, by Edward D. Goldberg.

3-3314. Romberg, Frederick E. **EXPLORATION GEOPHYSICS: A REVIEW:** Geol. Soc. America, Bull., v. 72, no. 6, p. 883-932, 19 figs., June 1961, approx. 300 refs.; abs. in French, Spanish, German, and Russian.

The art of exploration geophysics is reviewed with reference to classical and current literature. Its main features are described, the state of instrumentation and theory in it is discussed, and the problems it has yet to solve are examined.

Exploration geophysics is both a science and an industry. As a science it draws on its parent sciences of physics and geology, and it has a reciprocal relationship with its sister disciplines of seismology and geodesy. Since its predictions often cannot be verified, it lacks one indispensable ingredient of science - the power of self criticism. It also suffers because its discoveries are proprietary and therefore often not published to be built on or challenged. In spite of these handicaps, its scientific status is rising. More trained workers than ever before are in the field, and their publications are of better quality.

As an industry, exploration geophysics has long had the financial support that public funding has only recently given to science in general. It has served the demand for mineral discoveries well, but has sometimes failed to give the best possible support to its clients through lack of rapport between those who study problems and those who make decisions

about them.

The instruments and devices used by exploration geophysics have in general surpassed its fundamental needs. In 1930 the reflection seismograph was untested, and the field gravity meter was not invented, although they were clearly needed, and their prototypes, the refraction seismograph and the torsion balance, were plainly inadequate. Now it is possible to take almost any geophysical measurements found desirable, and the instrumental problem is usually to take them faster and with lighter and more dependable gear.

The present frontiers of the art are not in the observing of data but in their interpretation and application to the search for minerals. The interpretation of seismic records is still in a relatively primitive form. How far it will be developed in the future depends on how acutely it is needed, but it is not easy to see the end of the data-processing techniques that are now being studied. The interpretation of gravimetric, magnetic, electrical, and radioactivity observations still requires personal skill, although automatic computing techniques have been applied to the first 2 types.--Auth.

3-3315. Paterson, Norman R. **TRENDS AND PROSPECTS IN MINING GEOPHYSICS:** Can. Mining Jour., v. 82, no. 7, p. 45-47, 2 illus., July 1961.

Expenditures on geophysics in the Canadian mining industry are now at a 10-year low of 0.1% of the annual national mining budget. In contrast, the Canadian petroleum industry spends approximately 10% of its budget on geophysics. The difference is not due to a higher success rate in oil exploration. It is estimated that the cost of finding a \$2.00 barrel of oil ranges from \$1.00 to \$1.50 while the cost of finding a \$10.00 ton of Cu ore is about 20 to 40 cents.

Economic, technical, and occupational factors most seriously affecting mining geophysics are discussed, problems are outlined, and solutions suggested.

Recent developments with favorable impact on mining geophysics include AFMAG, nuclear precession magnetometers, 1- or 2-man seismic instruments, transient pulse electromagnetometers, and helicopter-borne instrument. The trend to use of a combination of geophysical methods is encouraging.--W.C. Peters.

3-3316. **EARTH DRILL PROPOSED:** Sci. News Letter, v. 79, no. 18, p. 278, May 6, 1961.

A rock drill consisting of a high-temperature nuclear reactor core to melt its way through the rock layers is feasible.--M. Russell.

3-3317. Lear, John. **CANADA'S CONTINENT-SPANNING LOOK INSIDE EARTH:** Saturday Rev., v. 44, no. 5, p. 35-40, 7 figs., Feb. 4, 1961.

The background, personalities, and progress in Canada's plan for participation in an upper mantle project proposed by the International Union of Geodesy and Geophysics is reported. A network of seismic stations spaced approximately 500 mi. apart is being installed to make continuous seismic readings. At each station, holes from 1,000 to 2,000 ft. deep will be drilled in order to take 100-ft. interval temperature records for study of the earth's heat flow. Magnetic and gravity surveys will be included.--M. Russell.

3-3318. de Castro, Honorato. VARIACIONES DE LA DENSIDAD Y DE LA PESANTEZ EN EL INTERIOR DE LA TIERRA [Variations of Density and Gravity in the Interior of the Earth]: Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 3/4, p. 169-176, Mar.-Apr. 1959; text in Spanish.

All hypotheses which express the variation in density of a stratum with depth must provide results which closely approximate the universally accepted geophysical data for such constants as mean density of the earth's crust, etc. Hypotheses which assume a mean density for the entire earth or which assume that the density increases as a continuous function of depth give results which are not acceptable. Only the assumption of a discontinuous function results in a close correspondence to the geophysical data.

Assuming the existence of 4 surfaces of discontinuity, the value of g , the acceleration due to gravity, is calculated to increase to 997 gals at a depth of 481 km., to decrease to a minimum of 981 gals at a depth of 1,500 km., to increase to 1,048 gals at 2,920 km., and to decrease again with depth, to the center of the earth.--A.M. Gutstadt.

3-3319. Tsimelzon, I.O. PROBLEM OF THE GEOLOGIC INTERPRETATION OF THE TALYSHKOVANDAM GRAVITY MAXIMUM: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 3-B, p. 195-204, map, 2 secs., 1959, pub. 1960, 24 refs.

A summary of the various opinions stated with respect to an extensive gravimetric maximum recorded in Azerbaijan by a pendulum survey. Recent detailed gravity surveys revealed that the zone of positive anomalies is made up of several maxima but confirmed its unity as a whole. A comparison is made with magnetic data, taking into account the probable depth in individual areas of the isothermal plane of 580°C., below which magnetite is demagnetized. It is concluded that a number of uplifts and downwarps exists, with, in several cases, volcanic and igneous rocks occurring near the surface. According to gravimetric calculations, part of the igneous rocks have to be basic. The structures found, some of which were confirmed by seismic surveys or by drilling, are referred to as the results of deep faulting with a large linear extent. Thus, great differences in thickness of the sedimentary section occurring sometimes over a rather short distance are also explained.--C. Voûte.

3-3320. Jensen, Homer. THE AIRBORNE MAGNETOMETER: *Sci. American*, v. 204, no. 6, p. 151-162, 11 figs., June 1961.

The airborne magnetometer is a valuable prospecting tool for several vital reasons: it is fast, independent of surface terrain, and nearly unaffected by motion, acceleration, or distances up to thousands of feet from the magnetic mass. [Its use in exploration for metals and petroleum is briefly described]. The fluxgate magnetometers, development of which was accelerated by its potential in detection of submerged submarines, made airborne surveys possible. A description of the device is included and some details of the proton precession magnetometer, as well as methods of adapting magnetometers to aircraft, and the technique of making a survey and converting it to a map.--Auth.

3-3321. Johnson, Robert W., Jr. DIMENSIONS AND ATTITUDE OF THE PERIDOTITE IN CLARK HOL-

LOW, UNION COUNTY, TENNESSEE: AN AEROMAGNETIC STUDY: *Southeastern Geology*, v. 2, no. 3, p. 137-154, 9 figs., March 1961, 8 refs.

An aeromagnetic survey was made of a small area in Union County, Tennessee, that is underlain by an altered mica peridotite body, the only known occurrence of igneous rock in Tennessee W. of the Blue Ridge Mountains. The areal extent of peridotite is obscure owing to poor exposures. Its position just beneath the Wallen Valley thrust fault led to the suggestion in earlier reports that the intrusive might occupy the fault plane.

Aeromagnetic data indicate that the peridotite does not dip southeastward along the Wallen Valley fault; rather, it occurs as a nearly vertical elliptical cylinder of approximate cross-sectional dimensions of 1,500 ft. by 3,000 ft. The intrusive mass apparently was emplaced prior to the formation of the Wallen Valley fault, or at least before the last significant movement along that fault.--Auth.

3-3322. Wheeler, Harold A. RADIO-WAVE PROPAGATION IN THE EARTH'S CRUST: *U.S. Natl. Bur. Standards, Jour. Research*, v. 65D, no. 2, p. 189-191, 3 figs., March-Apr. 1961, 3 refs.

There is a reasonable basis for postulating the existence of a useful waveguide deep in the earth's crust, of the order of 2 to 20 km. below the surface. Its dielectric is basement rock of very low conductivity. Its upper boundary is formed by the conductive layers near the surface. Its lower boundary is formed by a high-temperature conductive layer far below the surface, termed the "thermal ionosphere" by analogy to the well-known "radiation ionosphere" far above the surface.

The electrical conductivity of the basement rock has not been explored. An example based on reasonable estimates indicates that transmission at 1.5 kc/s might be possible for a distance of the order of 1,500 km.

This waveguide is located under land and sea over the entire surface of the earth. It may be useful for radio transmission from the shore to a submarine on the floor of the ocean. The sending antenna might be a long conductor in a drill hole deep in the basement rock; the receiving antenna might be a vertical loop in the water.--Auth.

3-3323. Leontev, V.M. SOME FEATURES OF INTERPRETATION OF MICROSONDE DIAGRAMS IN CARBONATE SECTIONS: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 4-B, p. 255-258, 2 logs, 1959, pub. 1961.

The relation is examined between low apparent resistivity of microsonde and microgradient sonde readings, the shape of the well, and the specific resistance of the drilling mud and of the mud cake on the sides of the well. From the construction of the microsonde, a situation often arises whereby the electrodes do not reach the walls of the borehole due to irregularities of the wall, which in turn are caused by the lithology or degree of fracturing of the rocks penetrated. In these cases the apparent resistance measured equals the specific resistance of the drilling mud. Therefore a correct interpretation of the logging diagrams necessitates the making of a large-scale caliper log as well.--C. Voûte.

3-3324. Hoskins, Hartley, and S. T. Knott. GEO-PHYSICAL INVESTIGATION OF CAPE COD BAY,

MASSACHUSETTS, USING THE CONTINUOUS SEISMIC PROFILER: Jour. Geology, v. 69, no. 3, p. 330-340, 15 figs., May 1961, 25 refs.

The Woods Hole Oceanographic Institution's continuous seismic profiler was used in Cape Cod Bay to make 200 mi. of reflection profiles and 8 oblique reflection-refraction stations. From these the areal extent and velocities of the principal seismic layers were determined.

The deepest layer found (having a compressional wave velocity of 15,000-16,500 ft. per sec.; 4.6-5.0 km. per sec.) is interpreted as Paleozoic in age. Its top surface forms an open-ended basin which deepens northeastward from the NE. entrance of Cape Cod Canal. Overlying it are patches of material (10,000-13,000 ft. per sec.; 3.0-4.0 km/s) which are interpreted as erosional remnants of Cretaceous sediments. Of still younger age are 3 horizons with material having a compressional wave velocity in the 6,000-8,000 ft. per sec. (1.8-2.4 km/s) range. The deepest seems likely to be marine Tertiary. The intermediate one is believed to be glacial till and the shallowest a thin covering of postglacial sediments.--Auth.

3-3325. Vartanov, S. P., and others. RESULTS OF SEISMIC EXPLORATION WORK ALONG THE PROFILE CHELEKEN-NEFTYANYE KAMNI: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 3-B, p. 192-194, map, 2 profiles, 1959, pub. 1960.

The results of a seismic survey along a line of 200 km. across the Caspian Sea are succinctly described. Registration of the seismic waves was carried out by using a piezoseismic string, towed behind a ship without disturbances resulting from waves or with interference background. The string consisted of Seignette salt receivers encased in a vinyl chloride tube. Several horizons in the upper Tertiary were traced from one shore to the other and the synchronicity of the Akh-agyl transgression confirmed in the Apsheron and Cheleken areas. In the W. a hitherto unknown uplift was observed on the Apsheron shelf, and in the E. indications were found for a seaward continuation of the central Pri-Balkhan zone of uplifts. A deep downwarp lies in between.--C. Voříte.

3-3326. Crews, William D. RADIOACTIVITY SURVEYING: Oil & Gas Jour., v. 59, no. 19, p. 132-

137, 10 figs., May 8, 1961, ref.

For some time, it has been known that a relationship exists between surface-radioactivity variations and the accumulation of hydrocarbons at depth. One hypothesis explains this phenomenon as "photodisintegration."

Use of the relationship as an exploration tool requires reliable measurements of radioactive intensity. This can only be done by statistical counting. The equipment used is illustrated. There are 2 general field-surveying techniques: 1) continuous traversing; 2) stationary recordings on predetermined grid patterns.--T. C. McLean.

3-3327. Fischer, William A. EARTHQUAKE EFFECTS AT YELLOWSTONE: Natl. Parks Mag., v. 34, no. 159, p. 10-13, 5 illus., Dec. 1960.

Effects in Yellowstone National Park from the earthquake of Aug. 17, 1959, include increased thermal activity, rejuvenated geysers, and considerable increase in discharge rates. A temperature rise of about 6° F. was recorded in water flowing from thermal springs.--M. Russell.

3-3328. Anpilogov, A. P. THE LITHOLOGIC CHARACTERISTICS OF THE PRODUCTIVE DEVONIAN SEDIMENTS OF THE TUYMAZY FIELD ACCORDING TO WELL LOGGING DATA: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 2-B, p. 109-113, 4 figs., 1959, pub. 1960.

Using the logs of 4 boreholes as an illustration it is shown that by combining various geophysical logging methods a detailed lithologic subdivision of a section can be achieved. It is possible to distinguish strata and beds, if only more than 0.5 m. thick, of sandstone, clays, limestones, clayey siltstone, and in several instances sorted siltstone. The following logging methods were used: neutron gamma log, gamma log, caliper log, microsonde, apparent resistivity, laterolog, and self potential. The standard apparent resistivity log is of little use for detailed lithologic subdivision; however the apparent resistivity gradient-sondes of various lengths in combination with other data give a far more differentiated profile which also gives some information about the clay content of sandstones and siltstones.--C. Voříte.

7. GEOCHEMISTRY

See also: Geomorphology 3-3237; Stratigraphy 3-3267; Geophysics 3-3313; Sedimentary Petrology 3-3408, 3-3409, 3-3410, 3-3412; Geohydrology 3-3423; Fuels 3-3463.

3-3329. Ringwood, A. E. CHANGES IN SOLAR LUMINOSITY AND SOME POSSIBLE TERRESTRIAL CONSEQUENCES: Geochim. et Cosmochim. Acta, v. 21, no. 3/4, p. 295-296, Jan. 1961, 3 refs.

On the basis of recent data it is suggested that the surface temperature of the earth has increased 30°-40°C. in the past 5 billion years. This would mean that more than 3 billion years ago the temperature was below 0°C., and the freezing of surface water would prevent most normal geologic processes such as erosion and sedimentation. Assuming that most granitic rocks are the result of metamorphism of former geosynclinal sediments, granites would be comparatively rare up to 3 billion years ago. Since

the majority of dated rocks are of granitic origin, a possible explanation for the scarcity of ages greater than 3 billion years is provided. It is also suggested that the Conrad discontinuity (boundary of the "intermediate layer" in the continents) may be the original surface of the earth about 3 billion years ago.--F. Manheim.

3-3330. Annell, C. S., and Armin W. Helz. A CONSTANT-FEED DIRECT-CURRENT ARC: U. S. Geol. Survey, Bull. 1084-J, p. 231-251, 9 figs., 3 tables, 1961, 28 refs.

The development of a constant-feed method for the continuous vaporization of successive increments of powdered rock and mineral samples into a 10-ampere direct-current arc is described. Long, deep-bore graphite electrodes having a 0.092-in. outer diameter

and a 1.5-in. bore depth of 0.046-in. diameter are used as sample anodes. Concomitant vaporization and excitation of such elements as Ti, Al, Si, Cu, Ge, As, and Pb, are obtained by gradually moving the electrode into the arc through a channel in a brass, water-cooled collar. The collar is placed on an electrode holder which was designed to permit controlled atmospheres to pass upward around the electrodes. A gas mixture flowing at the rate of 14 cu. ft. per hour Ar and 7 cu. ft. per hour O was selected to suppress cyanogen band interference in the spectra. Samples mixed with graphite power burn more evenly in the arc and show less selective volatilization than untreated samples. The addition of lithium borates to the sample and graphite generally enhances atom lines but tends to suppress ion lines. Tests of matrix influence are made in which intensity ratios of atom lines of Si, Al, Mg, and Fe are compared with ion lines of Fe, Ti, and Ca (in NaCl and ZrO_2 bases) for sample-graphite mixtures of 1:1 and sample lithium tetraborate graphite mixtures of 1:2:3. The ranges of percent deviation from a unity intensity ratio, which can be considered a measure of the matrix effect of NaCl and ZrO_2 , are 13-32% for atom lines in the graphite admixture, and 13-33% for the same lines in the Li buffered mixture. The ion lines show 23-55% and 16-27% deviations, respectively. Comparative results with the same sample compositions are given for more conventional 1/4 in. cupped graphite electrodes, for which an electrode holder is described. The above atom line intensity ratios for these electrodes deviate from unity by 30-65% and 12-36% respectively. Comparable deviations of the ion line ratios are 159-286% and 46-139%. Marked reductions in line broadening and self reversal are noted in the constant-feed direct-current arc.--Auth.

3-3331. Matthes, S. *ERGEBNISSE ZUR GRANAT-SYNTHESE UND IHRE BEZIEHUNGEN ZUR NATÜRLICHEN GRANATBILDUNG INNERHALB DER PYRALSPIT-GRUPPE* [Results on Synthesized Garnets and Their Relation to Natural Garnet Formation Within the Pyralspite Group]: *Geochim. et Cosmochim. Acta*, v. 23, no. 3/4, p. 233-294, 14 figs., 10 tables, May 1961, 85 refs.; text in German, abs. in English.

The synthesized garnets at relatively low hydrostatic pressures belong to limited pyralspite compositions. The experiments started at H_2O -pressures (or PH_2O+CO_2, P_{Ar}) of between 50 and 1,500 atm. and showed that pressures below 200 atm. had an increasingly unfavorable influence on the reaction of these garnets.

For the pure spessartite composition the lower reaction limit at pressures between about 200 and 1,500 atm. was at 410°C. For spessartite-almandite mixed crystals the limit rose with increasing almandite content from 410°C. (spess₉₀alm₁₀) to 500°C. (spess₅₀alm₅₀). Spessartite with a low content of pyrope already was obtainable from a reaction mixture (Mn₉₀Mg₁₀) at temperatures between 390 and 400°C. Some attempts have been made to demonstrate that these lower reaction limits correspond to the lower stability limits.

At a temperature of $t \sim 800^\circ C$. and under the pressures employed, the upper limit of reaction temperature (or breakdown temperature) had not yet been reached for any of the synthesized garnets.

The only pure garnet component in the pyralspite system which could be crystallized was spessartite, and neither almandite nor pyrope were obtained. Mixed crystals of spessartite with almandite were obtained up to a maximum almandite content correspond-

ing to spess₄₀₋₃₀alm₆₀₋₇₀. These mixed crystals (as also the pure spessartite component) were able to take up a maximum of about 15% of the pyrope component and of about 20% of the grossularite component. These limits correspond approximately to those found in natural mixed crystals.

Garnets obtained at temperatures below 700°C. possess a water content which increases in the lower temperature ranges and is present as the hydrospeessartite component without any clear dependence to the amount of water present.

The interpretation of some natural occurrences of the accentuated spessartite-almandite garnets in relation to the given experimental results is tried. Finally the formation of accentuated almandite garnets as a constituent of hornfelses in a thermal aureole and the relations between spessartite-hydrospeessartite are discussed in the light of the given experimental observations.--Auth.

3-3332. Smith, F. Gordon. *METALLIC SULPHIDE MELTS AS IGNEOUS DIFFERENTIATES*: *Can. Mineralogist*, v. 6, pt. 5, p. 663-669, 2 figs., 1961, 24 refs.

Liquidus data on the system FeS-FeO-SiO₂ is used to derive approximate relationships for the liquidus of the system pyrrhotite-magnetite-gabbroic silicates. Separation of a metallic sulfide liquid from the residual silicate liquid during crystallization of silicates is possible if the oxidation potential of the magma is below some critical value.--Auth.

3-3333. DuFresne, E. R., and Edward Anders. *THE RECORD IN THE METEORITES - V. A THERMOMETER MINERAL IN THE MIGHEI CARBONACEOUS CHONDRITE*: *Geochim. et Cosmochim. Acta*, v. 23, no. 3/4, p. 200-208, 4 figs., 2 tables, May 1961, 15 refs.

Mighei contains submicrogram fragments of strained glass of refractive index 1.55 which can be annealed at temperatures below 300°C. The time-temperature curve for annealing has been determined and serves as an upper boundary for the thermal experiences of the meteorite since the time its constituent minerals were brought together. Mighei cannot have been heated to 180°C. for more than a few weeks, to 250°C. for more than a fraction of an hour and can never have been heated to 300°C. Hypotheses concerning the origin of the glass are presented; their common element is the action of aqueous solutions. It is shown that thermal action alone is inadequate.--Auth.

3-3334. Marshall, R. R., and David C. Hess. *LEAD FROM TROILITE OF THE TOLUCA IRON METEORITE*: *Geochim. et Cosmochim. Acta*, v. 21, no. 3/4, p. 161-164, 2 tables, Jan. 1961, 15 refs.

Pb was isolated from troilite of the Toluca Fe meteorite and Pb isotope ratios determined mass spectrometrically. Assuming that the Pb originally had the isotopic of primeval Pb as reported by Patterson, and that the troilite contains U and Th in sufficient quantities, a Pb-Pb age of about 4.7×10^9 years may be calculated for the meteorite. Alternate possibilities are also discussed.--F. Manheim.

3-3335. Honda, Masatake, and James R. Arnold. *RADIOACTIVE SPECIES PRODUCED BY COSMIC*

RAYs IN THE AROOS IRON METEORITE: *Geochim. et Cosmochim. Acta*, v. 23, no. 3/4, p. 219-232, 2 tables, May 1961, 24 refs.

The Fe meteorite Aroos fell on Nov. 24, 1959. Using a sample received in Feb. 1960, the authors have measured the content of 18 cosmic-ray produced radioactive nuclides in this meteorite. All were separated by wet chemical methods. A low-level X-ray proportional counter was used for a group of electron-capture species; β - and γ -counting were used for the others. The activities of the long-lived species Be^{10} , Al^{26} , and Mn^{53} were close to those found previously in the meteorites Williamstown and Grant. The value for Cl^{36} was also consistent with earlier work. Much less K^{40} was found, indicating a shorter cosmic-ray age for Aroos.

Comparison of the activities of the groups Mn^{53} - Mn^{54} , Ti^{44} - Sc^{46} - Ca^{45} , Na^{22} - Al^{26} , and Cl^{36} - Ar^{37} - Ar^{39} indicates constancy of the cosmic-ray flux over millions of years with a factor of 2 or 3. Comparison of the groups Mn^{54} - V^{49} - Na^{22} , and Ti^{44} - Si^{32} , among others shows the great importance of low-energy particles in synthesizing products close to the target mass. Quantitative discussions will be given in a later paper.--Auth.

3-3336. METALLIC "METEORITES" FOUND IN TEKtITES: *Sci. News Letter*, v. 79, no. 18, p. 278, May 6, 1961.

Particulate impurities in a Philippine tektite, having the same Ni-Fe composition as meteorites, are strong evidence of the cosmic origin of tektites.--M. Russell.

3-3337. Shaw, D.M. COEFFICIENT OF ACCUMULATION. A MEASURE OF THE TOTAL TRACE ELEMENT CONTENT OF A MINERAL OR ROCK: *Can. Mineralogist*, v. 6, pt. 5, p. 694-697, table, 1961, 6 refs.

The coefficient of trace element accumulation R is a measure of the over-all concentration of trace elements in geological materials. If the concentration of element i is k_i and its crustal abundance is K_i , then

$$R = \frac{1}{n} \sum_{i=1}^n k_i / K_i$$

for the n trace elements determined. Structurally necessary major elements are excluded. Some applications of the coefficient are discussed.--Auth.

3-3338. Larsen, Esper S., Jr., and David Gottfried. DISTRIBUTION OF URANIUM IN ROCKS AND MINERALS OF MESOZOIC BATHOLITHS IN WESTERN UNITED STATES: *U.S. Geol. Survey, Bull.* 1070-C, p. 63-103, 4 figs., 38 tables, 1961, 27 refs.

Fluorimetric analyses for U have been made on a variety of igneous rocks and minerals from the southern California, Sierra Nevada, Idaho, and Coast Range batholiths. The U content of nearly 200 igneous rocks, ranging from gabbro to quartz monzonite, indicates that during magmatic differentiation U increases from about a half a part per million in the gabbroic rocks to about 4 p.p.m. in quartz monzonites. The extreme differentiates, chiefly muscovite-quartz monzonites, show a consistent decrease in their U

content as compared with ordinary quartz monzonites of about the same chemical composition. The U analyses do not fall on smooth variation curves as do the major constituents but show considerable scatter. This is especially true for the rocks ranging in composition from granodiorite to the quartz monzonites. Taking into consideration the areas underlain by the various rock types, the weighted-average U contents of the batholiths are as follows: southern California, 1.7 p.p.m.; Sierra Nevada, 2.7 p.p.m.; Idaho, 2.5 p.p.m.; and the Coast Range, 2.7 p.p.m. The weighted-average U content of the 4 batholiths is approximately 2.5 p.p.m.

U determinations on the major minerals and many of the accessory minerals of 26 igneous rocks show that in most rocks the major rock-forming minerals contain the bulk of the U present in the rock. In general, there is an average increase in the U content of a given mineral from the mafic to the siliceous rocks.

The amount of U soluble in acid (hot 1 + 4 HCl) was determined in 6 igneous rocks representing the major rock type of the southern California batholith. The present soluble U ranged from 40% in a calcic gabbro to 83% in a quartz monzonite. Similar acid treatment of the major minerals of 4 igneous rocks shows that the bulk of the U contained in separated fractions of quartz, feldspar, and the mafic minerals is readily dissolved.--Auth.

3-3339. Teodorovich, G.I. AUTHIGENIC MINERALS IN SEDIMENTARY ROCKS. Authorized translation from the Russian: 120 p., 27 figs., 15 tables, New York, Consultants Bureau, 1961, approx. 240 refs.

This work is designed for the broad circle of lithologists, and also for geologists and geochemists who are studying sedimentary rocks and ores. Its specific purpose is to interest lithologists and geologists in the geochemical environment associated with the formation of authigenic minerals in sedimentary rocks, to encourage work in tracing the sequence of formation of these minerals, and to direct attention to other genetic problems.

The book is not a determinative atlas of the authigenic minerals in sedimentary rocks; its task is to draw the reader's attention to questions of origin and, at the same time, to equip him with systematic knowledge about the physical and, especially, the optical properties of these minerals. The simplified chemical reactions indicated in the book will permit one to distinguish similar minerals, and will also allow him to detect various mineral deposits in the field. Another purpose of the book is to acquaint chemists and geochemists with the properties of the minerals they study in making chemical analyses, minerals that commonly occur as polymineralic aggregates in the samples examined.

A considerable amount of information has been accumulated concerning authigenic minerals in sedimentary rocks as indicators of the physiochemical conditions at the time of their formation in the sediments or during lithification of the rocks; this matter is discussed briefly in Chap. 1. A considerable quantity of material has also been gathered on the problem concerning phases of formation of sedimentary rocks and ores, but there is no agreement on this question. A lack of harmony in the concepts concerning the separate stages of rock formation makes it necessary to generalize the mineralogical descriptions of the successive stages in the growth of sedimentary rocks and ores. The author attempts to answer these ques-

tions in Chaps. 2 and 3.

Most attention in this book is given to primary chemical minerals and to diagenetic (syngenetic) minerals of sedimentary rocks in the broad sense of the word. Considerable space is devoted to descriptions of the carbonate minerals, glauconite and iron chlorites, sedimentary aluminosilicates of the "clay group," zeolites, iron and manganese oxides and hydroxides, and calcium and iron phosphates.

We are now realizing more and more the important role of colloids, both during transfer of material in the surficial parts of the earth's crust and during sedimentation and mineral development in already-formed rocks. These problems are considered by the author in Chaps. 4 and 5.--From pref.

3-3340. Stadnichenko, Taisia M., and others. BERYLLIUM CONTENT OF AMERICAN COALS: U. S. Geol. Survey, Bull. 1084-K, p. 253-295, 5 figs., 2 pls. (in pocket), 8 tables, 1961, 30 refs.

The results of spectrochemical analyses of 1,385 coal ash samples suggest a significant distribution pattern for Be. The highest average Be content of coal ash (62 p.p.m.) was found in the Appalachian region. An average content of Be in ash of 49 p.p.m. was found in the Interior province. This figure for the Interior province is very close to the average for all the coal samples studied, 46 p.p.m. The average Be content of the samples from the northern Great Plains and Rocky Mountain provinces is about one-half the average for all the coal ash samples examined.

Considerable variation in Be concentration exists within each of the provinces. In the Eastern province very high concentrations of Be in ash are found in eastern Kentucky (0.067% and 0.081%). In the Interior province, the Eastern region has a higher Be content in the coal beds along the N. and SE. edges and a lower content in the central parts; in the Western region, the coal beds of the McAlester basin (Oklahoma and Arkansas) have a much lower content of the element than do the coal beds of the central and northern parts of the region. In the northern Great Plains province a similar distribution is found; the coal beds of the Great Falls and the Lewistown fields have a much higher Be content than do those of the rest of this province.

Large variations are found in concentrations of Be in different samples of the same bed. The Be content of bed 5 of Illinois ranges from 0.0011% (9.52% ash) to 0.0050% (6.52% ash). Similar variations are noted in other beds from which 2 or more samples were collected and analyzed. The distribution of Be in the blocks of columnar coal samples is reasonably uniform. In a few, however, concentrations were found in the top, center, or bottom part of the bed.

A study of the various types of coal indicates that Be is primarily concentrated in vitrain. Float-sink experiments clearly show that the concentration of Be is in the coal substance.

A study of the data has led to the belief that the accumulation of Be by coal was a syngenetic process. Conclusions have been reached that a) the Be content of the coal is primarily dependent on the Be content of the rocks that contributed material to the coal-depositional sites, b) the position in the basin determined the amount of Be in the coal samples, c) rank and age of the coal bed is not related to the Be content of the coal, and d) the chemical properties of Be suggest a way by which the element can be released from rocks, can be transported to a coal depositional site, and can become fixed in the coal.--Auth.

3-3341. Duchesne, J., and others. ORIGIN OF FREE RADICALS IN CARBONACEOUS ROCKS: *Geochim. et Cosmochim. Acta*, v. 23, no. 3/4, p. 209-218, 4 figs., table, May 1961, 26 refs.

The problem of the genesis of free radicals encountered in coals, lignites, peats, and petroleum is analyzed. Two hypotheses concerned with the botanical origin and the effect of natural radioactivity are put forward. Whereas the former is able to give account of the facts for peats, the latter, combined with the geothermal hypothesis, allows us to afford a general solution for this problem.--Auth.

3-3342. Nagy, Bartholomew, and George C. Gagnon. THE GEOCHEMISTRY OF THE ATHABASCA PETROLEUM DEPOSIT. I. ELUTION AND SPECTROSCOPIC ANALYSIS OF THE PETROLEUM FROM THE VICINITY OF McMURRAY, ALBERTA: *Geochim. et Cosmochim. Acta*, v. 23, no. 3/4, p. 155-185, 9 figs., 8 tables, May 1961, 49 refs.

The sandstone and shale beds of the McMurray formation are impregnated with a semi-solid petroleum. The Athabasca deposit is the largest known petroleum deposit in the world. Sandstone samples from the bottom of the Abasand quarry, near McMurray, yielded 16.5% organic matter upon extraction with methylene chloride. The extract contained approximately 22% asphaltenes. It also contained large quantities of residuum upon distillation at 350°C. temperature at atmospheric pressure. The extract was fractionated by elution chromatography on silica gel and aluminum oxide columns. Mass spectrometric methods of analysis revealed the presence of paraffin and naphthenic hydrocarbons in one eluate fraction (9% of the total extract) and of alkyl benzenes, cyclo-alkyl benzenes, naphthalenes, phenanthrenes and some sulfur compounds in another fraction (18% of the total extract). Nitrogenous compounds, such as pyrroles and pyridines, may also be present. In addition, the eluate fractions were also analyzed by infra-red and ultra-violet spectroscopy. The study formed a part of an investigation of the chromatographic-type fluid flow in the sedimentary rock strata.--Auth.

3-3343. Durum, Walton H., and Joseph Haffty. OCCURRENCE OF MINOR ELEMENTS IN WATER: U. S. Geol. Survey, Circ. 445, 11 p., 4 figs., 2 tables, 1961, 9 refs.

Three basic studies, using spectrographic methods, have been used to establish the occurrence of minor elements in natural waters. One study, of ocean-borne chemical in principal rivers, has established a method for the quantitative analysis of many minor elements. Sr, Ba, Li, Rb, Cr, Ni, Cu, Pb, B, Ti, Mo, Mn, and V occur most frequently in measurable quantities.

Reconnaissance of the Sr in surface waters of the United States, shows that surface waters in parts of northern and western Texas and southern New Mexico and Arizona are comparatively high in Sr. A study of minor elements in selected waters of California is continuing.

Assessment of preliminary data on U and Ra in waters is facilitated by grouping data for 10 geotectonic regions of the United States.--Auth.

3-3344. Gorham, Eville. FACTORS INFLUENCING SUPPLY OF MAJOR IONS TO INLAND WATERS, WITH SPECIAL REFERENCE TO THE ATMOSPHERE: *Geol. Soc. America, Bull.*, v. 72, no. 6, p. 795-840, 3 figs., 23 tables, June 1961, 217 refs.;

abs. in French, Spanish, German, and Russian.

Sources of ion supply to natural inland waters include not only rocks and soils but also the atmosphere, whose significance has been underestimated. Atmospheric materials are transferred to surface waters by rain or snow, as dry fallout, or in gaseous form; the sources are the sea, land surfaces, volcanoes, products of air pollution, or organic debris. Ion supply by soil and rock weathering, which is usually more important than atmospheric supply, involves solution, oxidation-reduction reactions, activity of H ions, and complex formation. Transfer from soils to waters is influenced by ion exchange and by modes of water percolation.

Five principal environmental factors - climate, geology, topography, biota, and time - interact to determine ionic concentration and composition of atmospheric precipitation, soil solutions, and lake and river waters, although the extent to which each applies is not well understood. Investigation of situations in which only a single factor varies effectively should do much to clarify the role of each in determining the ultimate composition of natural waters.--Auth.

3-3345. Dugdale, Richard C., and Vera A. Dugdale. SOURCES OF PHOSPHORUS AND NITROGEN FOR LAKES ON AFOGNAK ISLAND: *Limnology & Oceanography*, v. 6, no. 1, p. 13-23, 6 figs., 3 tables, Jan. 1961, 17 refs.

The contribution of inlet streams to the P and N budgets of 2 lakes on Afognak Island (Kodiak Region), Alaska, has been studied with special reference to the morphology of the associated watersheds. One lake drains a steep, vast watershed, the other, a relatively flat, restricted one. Streams coming from the steeper slopes show a lower $\text{PO}_4\text{-P}$ concentration than those coming from shallow slopes as might be expected from runoff-residence considerations. Exactly the opposite is found when the nitrate concentration of these streams is examined, i.e., only the streams arising on steep slopes show appreciable amounts of nitrate. P appearing in the inlets probably originates in the Katmai ash which lies just under the humus layer of soil. Three distinct layers of ash occur normally. A complex pattern of P distribution can probably be attributed to differences in the permeability of these layers to water. A model has been constructed as an aid to interpretation of the data. Thickets of N fixing alders, found only along steep stream banks, may be the source of the nitrate content of these streams.--Auth.

3-3346. Heron, J. THE SEASONAL VARIATION OF PHOSPHATE, SILICATE, AND NITRATE IN WATERS OF THE ENGLISH LAKE DISTRICT: *Limnology & Oceanography*, v. 6, no. 3, p. 338-346, 5 figs., July 1961, 10 refs.

A record is presented of 2 years continuous observations, from Jan. 1958, to March 1960, of the N. and S. basins of Windermere, Esthwaite Water, and Blelham Tarn. The changes in phosphate concentration together with data for silicate and nitrate are shown. Rainfall, temperature, and total diatom population are also included. An improved method for the determination of phosphate has made possible the recognition of a vernal decline and subsequent autumnal increase in the concentration of this constituent. The changes in the chemical composition of the water are attributed to the influence of conditions

in the catchment area rather than changes in the lake itself.--Auth.

3-3347. Lowenstam, Heinz A. MINERALOGY, $\text{O}^{18}/\text{O}^{16}$ RATIOS, AND STRONTIUM AND MAGNESIUM CONTENTS OF RECENT AND FOSSIL BRACHIPODS AND THEIR BEARING ON THE HISTORY OF THE OCEANS: *Jour. Geology*, v. 69, no. 3, p. 241-260, 6 figs., 3 tables, May 1961, 24 refs.

The calcareous shells of recent articulate brachiopods and fossils of the same class dating back to the Mississippian are investigated for their crystal form, $\text{O}^{18}/\text{O}^{16}$ ratios, and SrCO_3 and MgCO_3 contents. In the case of recent forms it is shown that temperature affects $\text{O}^{18}/\text{O}^{16}$ ratios, SrCO_3 and MgCO_3 contents, and consequently Sr/Ca and Mg/Ca ratios. The SrCO_3 and MgCO_3 contents are investigated in samples from waters of $35\text{‰} \pm 1.5\text{‰}$ salinity over the range of temperatures from 10°C . to 26°C . As is true for the O^{18} concentrations, the uptake of Sr and Mg in the shells is shown to be sensitive also to changes in the concentrations of the 2 trace elements in sea water.

The $\text{O}^{18}/\text{O}^{16}$ ratios and the SrCO_3 and MgCO_3 contents in fossil samples of Pliocene, Cretaceous, Permian, and Mississippian age were determined. Samples as old as the early Permian have been found in which the relationship of $\text{O}^{18}/\text{O}^{16}$ ratios and the SrCO_3 and MgCO_3 contents are similar to recent species. The relation of the $\text{O}^{18}/\text{O}^{16}$ ratios to the SrCO_3 contents in a late Mississippian sample is also similar to that in recent species. These findings make it probable that the original $\text{O}^{18}/\text{O}^{16}$ ratios and SrCO_3 and MgCO_3 contents in these fossils are the original ones. In other samples the relations of the relative concentrations of 1, 2, or all 3 constituents indicate diagenetic alterations by fresh water.

The significance of the chemical similarity of the fossil samples to recent shells is discussed. It is concluded that the results are best explained if it is assumed that the O^{18} , Sr, and Mg contents, and the Sr/Ca and Mg/Ca ratios in the oceans have remained essentially constant during the last 2.0 to 2.5×10^8 years.--Auth.

3-3348. Hoering, Thomas C., and P.L. Parker. THE GEOCHEMISTRY OF THE STABLE ISOTOPES OF CHLORINE: *Geochim. et Cosmochim. Acta*, v. 23, no. 3/4, p. 186-199, 7 tables, May 1961, 22 refs.

A procedure for measuring small differences in $\text{Cl}^{37}\text{-Cl}^{35}$ ratios was developed. It was tested by measuring the Cl isotope fractionation in the following isotopic exchange reactions: a) ammonium chloride, hydrogen chloride; b) solid sodium chloride, aqueous chloride ion; c) Cl, hydrogen chloride; d) aqueous hexachloroplatinate (IV), chloride ion. The $\text{Cl}^{37}\text{-Cl}^{35}$ ratio in 81 samples of natural occurrence was investigated. No significant variations in the ratio was observed. The results are discussed in terms of geochemical cycle of Cl.--Auth.

3-3349. Hamilton, D.L. NEPHELINES AS CRYSTALLIZATION TEMPERATURE INDICATORS: *Jour. Geology*, v. 69, no. 3, p. 321-329, 3 figs., 3 tables, May 1961, 22 refs.

In the system $\text{NaAlSi}_3\text{O}_8\text{-KAlSi}_3\text{O}_8\text{-SiO}_2\text{-H}_2\text{O}$ the limits of solid solution of nepheline have been determined at 775° , 700° , and 500°C . The crystallization

temperatures of a number of natural nephelines have been deduced using the experimental results. The possible chemical changes in the composition of nepheline with falling temperature are discussed. A nepheline in equilibrium with a silicate liquid will change composition in 2 ways: a) change in the K/Na

ratio and b) change in the Si/Al ratio, Si being replaced by Al. It is suggested that, in postmagmatic cooling, only the Na and K atoms move, and these are exchanged with the alkali atoms in the accompanying feldspar in such a way that the Na:K ratio of the nepheline approaches 3:1--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Stratigraphy 3-3257; Geochemistry 3-3331, 3-3339; Igneous Petrology 3-3393; Mineral Deposits 3-3460.

3-3350. Dennen, William H. **PRINCIPLES OF MINERALOGY**. Revised Printing with Determinative Tables: 453 p., illus., diags., graphs, tables, New York, Ronald Press, 1960, refs.

This printing includes a new Appendix II of Determinative Tables. These tables have 265 entries in 8 sections and cover 191 minerals. To show the progressive hardness of the minerals listed in each section, a graphic scale of hardness has been introduced along with hardness numbers. It is hoped that the tables will serve as a teaching tool as well as a reference source.--Auth.

The original printing was listed as GeoScience Abstracts 2-406.

3-3351. Meyrowitz, Robert, and others. **N,N-DIMETHYLFORMAMIDE, A NEW DILUENT FOR METHYLENE IODIDE HEAVY LIQUID**: Am. Mineralogist, v. 45, no. 11/12, p. 1278-1280, table, Nov.-Dec. 1960, 5 refs.

N,N-Dimethylformamide (DMF), $\text{HCON}(\text{CH}_3)_2$, is recommended as a superior diluent for methylene iodide. When the liquids are stored in contact with Cu they remained transparent after 7 months. In all other respects, its properties are similar to previously suggested diluents.--D.O. Emerson.

3-3352. Bloss, F. Donald. **AN INTRODUCTION TO THE METHODS OF OPTICAL CRYSTALLOGRAPHY**: 294 p., illus., col. chart, diags., graphs, tables, New York, Holt, Rinehart and Winston, 1961, 32 refs.

This text has been written specifically for the beginning student in optical crystallography. Description of advanced techniques or of numerous alternative techniques have been largely omitted in favor of a rather thorough but simple presentation of the basic techniques for determining the optical constants of crystals, using only a polarizing microscope and immersion media. Both the theory and the practical methods of optical crystallography have been accorded coverage in a proportion that, it is hoped, will best suit the needs of the student. The determination of the refractive indices of solids by the oil immersion method has been discussed in more detail than usual, following the suggestion of Emmons and Gates that more use be made of the colored dispersion fringes at grain boundaries. A set of determinative tables whereby over 1,000 mineral specimens may be identified from their refractive index data is included in the Appendix. This organization and emphasis have been followed in the hope that the student in optical mineralogy will no longer need to consult 3 different types of books - one for theory, a second for practical methods, and a third for determinative tables - in order to attain an adequate grasp of the sub-

ject.--From auth. pref.

Chapters cover the following subjects: light and related phenomena; light in isotropic media; lenses and the compound microscope; polarizing microscope; optical examination of isotropic substances; optical indicatrices and ellipses; interference of light; optical examination of uniaxial crystals; biaxial crystals; optical examination of biaxial crystals; solution of optical problems by use of projections.

3-3353. Ruthberg, Stanley. **TELESCOPE FOR MEASUREMENT OF OPTIC ANGLE OF MICA**: U.S. Natl. Bur. Standards, Jour. Research, v. 65C, no. 2, p. 125-128, 8 figs., Apr.-June 1961, 6 refs.

The described instrument allows rapid measurement of the apparent optic angle to an accuracy of 5' of arc for samples as large as 2 in. in diameter. This angle is a property pertinent to the quality of mica. Instrumentation is quite simple but dependent upon the complex phenomena of interference figures produced by biaxial crystals in polarized light. Magnification is great, dispersion can be determined, and the uniformity of samples can be observed.--Auth.

3-3354. Poindexter, Edward H. **A NOTE OF THE STRAIN-DEPENDENCE OF REFRACTIVE INDEX IN CRYSTALS**: Am. Mineralogist, v. 45, no. 11/12, p. 1297-1300, Nov.-Dec. 1960, 7 refs.

The author's previous mathematical expression relating polarizability to electron distribution (American Mineralogist, v. 40, p. 1032, 1955) can be simplified to become identical with results of earlier authors. No rigorous calculation has been made of the strain-dependence of polarizability or the closely related refractive index of crystals.--D.O. Emerson.

3-3355. Rex, Robert W., and R.G. Chown. **PLANCHET PRESS AND ACCESSORIES FOR MOUNTING X-RAY POWDER DIFFRACTION SAMPLES**: Am. Mineralogist, v. 45, no. 11/12, p. 1280-1282, 3 figs., Nov.-Dec. 1960, 5 refs.

Samples ground finer than 15 microns are packed by a modified pellet press into monel rings. In these mounts, samples show minimum preferred orientation and are easily manipulated on both G.E. and modified Norelco equipment.--D.O. Emerson.

3-3356. Hawes, Lorin. **THE DEVELOPMENT OF AN ACCURATE LOW ANGLE X-RAY POWDER DIFFRACTION CAMERA**: Am. Mineralogist, v. 45, no. 11/12, p. 1288-1296, 5 figs., 2 tables, Nov.-Dec. 1960, 3 refs.

A diffraction camera that holds film in a circular cylinder coaxial with the X-ray beam and the specimen in a plane perpendicular to the beam is described. With this camera a nearly linear relationship exists

between the measured film distance and the interplanar spacing in the crystal. This greatly increases the accuracy of low angle powder diffraction data.--D.O. Emerson.

3-3357. Salmon, Merlyn L. THE EFFECTS OF OPERATING VARIABLES IN THE APPLICATION OF MULTIELEMENT CALIBRATION SYSTEMS FOR FLUORESCENT X-RAY SPECTROGRAPHIC ANALYSES OF MINERAL SAMPLES (In: Mueller, William M., ed. *Advances in X-Ray Analysis*, Volume 4: p. 433-456, 2 figs., 2 tables, New York, Plenum Press, 1961) 10 refs.

A highly simplified multielement calibration system for semiquantitative analyses of mineral samples by fluorescent X-ray spectrography was discussed at the Eighth Annual Conference on Applications of X-ray Analysis. This system relates scattered radiation intensity (background) with peak intensity as measured on a chart recording to determine concentrations of several elements in a sample.

A continuation of the study reveals the effects of operating variables such as: 1) sample preparation and choice of sample type; 2) operating power and target choice of the X-ray tube; 3) collimation ratio; 4) goniometer scanning rate; 5) choice of method for measurement of background intensity; and 6) control and adjustment of detector, scaler-ratemeter, recorder, and other electronic circuits.

The over-all effects of some operating variables are negligible owing to the compensatory nature of the calibration system. The net effects of others can be directly attributed to particular operating conditions, and these conditions can be controlled to achieve an optimum balance of effects to yield the desired results for accuracy, time required to complete the analyses, and other important requirements in the analyses of minerals.--Auth.

3-3358. Hargreaves, Arnold. THE USE OF OPTICAL TRANSFORMS IN CRYSTAL-STRUCTURE ANALYSIS (In: Mueller, William M., ed. *Advances in X-Ray Analysis*, Volume 4: p. 1-18, 12 figs., New York, Plenum Press, 1961) 11 refs.

Optical transforms are of particular value in the earlier stages of crystal-structure determination; they enable trial structures to be tested rapidly and may indicate the nature of changes which will improve a postulated structure. The optical transforms are produced in a simple instrument called an optical diffractometer. The projected positions of the atoms in a postulated structure are represented by a set of holes punched in a mask, and the diffractometer produces the Fraunhofer diffraction pattern of the mask. The distribution of intensity in the optical transform is comparable, when sampled at suitable intervals, with the distribution of intensity among the observed intensities in a particular zone of X-ray reflections. The use of optical transforms in the determination of crystal structures and in the study of imperfect structures are illustrated by examples.--Auth.

3-3359. Weir, Charles E., and Ellis R. Lippincott. INFRARED STUDIES OF ARAGONITE, CALCITE, AND VATERITE TYPE STRUCTURES IN THE BORATES, CARBONATES, AND NITRATES: U.S. Natl. Bur. Standards, Jour. Research, v. 65A, no. 3, p. 173-183, 16 figs., 4 tables, May-June 1961, 22 refs.

Infrared absorption spectra have been obtained on the alkali nitrates, the divalent metal carbonates, and the rare earth borates which assume the aragonite, calcite, or vaterite crystal structures. It was observed that similar structures give rise to analogous spectra except for the carbonate and borates having the vaterite structure. The marked differences observed in these latter spectra are discussed. Frequency shifts produced by cation substitution are ascribed to repulsion between closed electron shells of O atoms. It is concluded that this repulsive force determines the structure type in the rare earth borates.--Auth.

3-3360. Hawes, Lorin. A METHOD FOR THE DIRECT DETERMINATION OF LATTICE PARAMETERS: *Am. Mineralogist*, v. 45, no. 11/12, p. 1285-1288, Nov.-Dec. 1960, 4 refs.

Random errors in lattice parameter determinations are minimized by finding values of Q_{hkl} (where $Q = 1/d^2$) for each reflection and combining these by the method of least squares. Derivations and formulas for the cubic, tetragonal, and orthorhombic systems are given.--D.O. Emerson.

3-3361. Goldsmith, Julian R., and others. LATTICE CONSTANTS OF THE CALCIUM-MAGNESIUM CARBONATES: *Am. Mineralogist*, v. 46, no. 3/4, p. 453-457, 2 figs., 3 tables, March-Apr. 1961, 3 refs.

Single phase solid solutions were prepared ranging from calcite [CaCO_3] to dolomite [$\text{CaMg}(\text{CO}_3)_2$], and the lattice constants were measured. The data show the change in cell size accompanying cation disorder in dolomite. Cell constants for synthetic disordered solid solutions and natural dolomites are given. Disorder in dolomite produces a slight decrease in a_0 and an increase in c_0 .--K.A. Riggs.

3-3362. Burley, B. J., and others. STUDIES ON SCAPOLITE: *Can. Mineralogist*, v. 6, pt. 5, p. 670-679, 3 figs., 5 tables, 1961, 11 refs.

An X-ray method has been developed which permits the identification of the variety of scapolite more rapidly and with less skill than by optical methods.--Auth.

3-3363. Griscom, Andrew. THE BULK COMPOSITION OF A ZONED CRYSTAL: *Am. Mineralogist*, v. 45, no. 11/12, p. 1309-1312, fig. Nov.-Dec. 1960, ref.

A graph is given which permits the determination of the bulk composition of zoned crystals if the compositional variations from the nucleus to the rim are known and if this variation approximates some power function of the distance from the nucleus.--D.O. Emerson.

3-3364. Johnson, Noye M., and others. THERMOLUMINESCENCE MEASUREMENTS WITH RAPID HEATING: *Am. Mineralogist*, v. 46, no. 3/4, p. 447-450, 3 figs., March-Apr. 1961, 5 refs.

Thermoluminescent equipment is briefly described which normally uses a heating rate of 20° to 30° C. per sec., but which can heat as fast as 90° C. per sec. A complete analysis of a sample can be run in 5 min.

This fast heating equipment is more sensitive to low levels of thermoluminescence, but the temperature control and precision is not as good.

Thermoluminescence sensitivity is controlled by using a ring mold to vary sample volume, geometry, and heating environment. A wide range of thermoluminescent intensities can be measured by varying the sample size and/or regulating the heating rate.--K. A. Riggs.

3-3365. Philpotts, A. R. TEXTURES OF THE UNGAVA NICKEL ORES: *Can. Mineralogist*, v. 6, pt. 5, p. 680-688, 7 figs., 1961, 4 refs.

The Ni deposits of the Cape Smith-Wakeham Bay belt have been formed by the selective replacement of ultrabasic rocks (and to a minor degree sediments). The replacement began soon after the commencement of serpentinization of the ultrabasics. Sulfides of Fe, Ni, and Cu replaced unaltered portions of the olivine and pyroxene but none of the alteration minerals, such as serpentine and amphibole. The textures exhibited by the sulfides, therefore, are those normally associated with the silicate minerals of basic igneous rocks. The mineralization probably originated from the serpentinization of olivine and pyroxene which contained small amounts of Cu and Ni.

The hypothesis of Wager, Vincent, & Smales, which claims that nickeliferous pyrrhotite deposits are the product of basic magma in which the S pressure was high enough during the early stages of crystallization to cause the Ni to form sulfides rather than entering olivine and pyroxene, does not seem to apply to the Ni deposits of the Cape Smith-Wakeham Bay belt.--Auth.

3-3366. Hawley, J. E., and others. PSEUDO-EUTECTIC INTERGROWTHS IN ARSENICAL ORES FROM SUDBURY: *Can. Mineralogist*, v. 6, pt. 5, p. 555-575, 10 figs., table, 1961, 12 refs.

Pseudo-eutectic intergrowths involving niccolite, chalcopyrite, pyrrhotite, and maucherite in Sudbury [Ontario] ores have been observed to develop chiefly by replacement of gersdorffite without the latter participating essentially as a component of the 2- or 3-phase aggregates. As shown previously niccolite, by loss of As, may likewise develop niccolite-maucherite intergrowths. New experiments confirm the reactions by which gersdorffite forms niccolite-maucherite intergrowths and the subsequent replacement of maucherite by chalcopyrite to form a niccolite-chalcopyrite aggregate. Niccolite-pyrrhotite and maucherite-pyrrhotite intergrowths may be due simply to breakdown of ferroan gersdorffite, though the former is also developed by normal replacement of pyrrhotite by niccolite. Conditions for their development require elevated temperatures and a lowering of S (and As) vapor pressure, but reactions do not proceed under appreciable pressures of S. The intergrowths seem best explained as late-stage alterations, involving introduction of quartz and carbonates and remobilization of Cu and other constituents, accompanying deep-seated fracturing.--Auth.

3-3367. Bideaux, Richard A. ORIENTED OVERGROWTHS OF TENNANTITE AND COLUSITE ON ENARGITE: *Am. Mineralogist*, v. 45, no. 11/12, p. 1282-1285, 4 figs., Nov.-Dec. 1960, 5 refs.

Overgrowths of tennantite occur on the {001} {010} and {110} faces of enargite from Cerro de Pasco,

Peru. In the orientation, {111} [111] tennantite // {001} [001] enargite, with one apex of tennantite tetrahedra pointing towards the enargite {001} and opposite edges paralleling the [010] [210] or [210] of the enargite. In the same manner colusite twins are oriented on {001} of enargite prisms from Butte, Montana.--D. O. Emerson.

3-3368. Hogarth, D. D. A STUDY OF PYROCHLORE AND BETAFITE: *Can. Mineralogist*, v. 6, pt. 5, p. 610-633, 7 figs., 7 tables, 1961, 39 refs.

Pyrochlore and betafite were investigated from several types of Canadian occurrences. Nine new analyses for 20 constituents and 11 analyses for 8 constituents are presented. A general formula $A_{16-x}B_{16}(O, OH)_{48}(F, OH)_8$ is proposed for the pyrochlore-betafite series with x representing vacant sites in the unit cell. Differential thermal and thermogravimetric curves indicate 2 states of water. Betafite and thorian pyrochlore are metamict, but recrystallization can begin well below the exothermic reaction indicated on D.T.A. curves. The cell edge of ignited minerals tends to decrease as Ti and Fe increase. Molecular weights derived from density-cell edge data correspond qualitatively to those calculated from analyses. Observed X-ray intensities agree with calculated values, but the role of Fe is uncertain. Frequency diagrams suggest a natural division of pyrochlore and betafite at 15% U.--Auth.

3-3369. Qurashi, M. M. THE POLYMORPHISM AND HYDRATION CHARACTERISTICS OF HEWETTITE AND METAHEWETTITE: *Can. Mineralogist*, v. 6, pt. 5, p. 647-662, 7 figs., table, 1961, 5 refs.

Hewettite and metaheawettite, as described by Hillebrand, Merwin & Wright may be considered as $CaO \cdot 3V_2O_5 \cdot nH_2O$, where 'n' depends upon the humidity and varies from a minimum of 3 to a maximum of 9. The crystallographic study of the hydration and dehydration of these minerals is presented here and leads to several important conclusions.

Weissenberg photographs of the material described by Hillebrand, et al show that it undergoes very marked changes in its structure during dehydration from $9H_2O$ to $3H_2O$ per molecule. One structure (space group $P2_1/m$, $Z=1$) persists from $9H_2O$ down to somewhat above $5H_2O$, at which stage a discontinuous transition takes place to a new structure with space group $A2/m$, $Z=2$. (This transition is accompanied by strong streaking of some of the spots in the c^* direction.) Following Weeks, the 2 structures are designated as hewettite and metaheawettite, respectively. The expulsion of water is at every stage accompanied by a contraction of the unit cell.

All the changes are found to be reversible, inasmuch as the hewettite structure is regained after hydration; the whole cycle of changes was repeated several times by surrounding the crystal with a special transparent controlled-humidity chamber. General relationships between the structures of the 2 forms, hewettite and metaheawettite, and the Na-analogue of metaheawettite ($NaO \cdot 3V_2O_5 \cdot 3H_2O$), are brought out.--Auth.

3-3370. Switzer, George S., and Howard Eugene Swanson. PARATELLURITE, A NEW MINERAL FROM MEXICO: *Am. Mineralogist*, v. 45, no. 11/12, p. 1272-1274, table, Nov.-Dec. 1960, ref.

Sparing amounts of paratellurite (tetragonal TeO_2)

occur with tellurite (orthorhombic TeO_2) in thin seams of native Te at Cananea, Sonora, Mexico. The new mineral gives an X-ray powder pattern identical with synthetic tetragonal TeO_2 and occurs as fine-grained aggregates, either massive or pseudomorphous after tellurite. Attempts to synthesize tellurite failed.--D.O. Emerson.

3-3371. Jambor, J.L. VOLBORTHITE FROM BRITISH COLUMBIA: *Am. Mineralogist*, v. 45, no. 11/12, p. 1307-1309, 2 tables, Nov.-Dec. 1960, ref.

Volborthite, $\text{Cu}_3(\text{VO}_4)_2 \cdot 3\text{H}_2\text{O}$, is a weathering product of the carbonaceous material in a thin, inter-lava sedimentary rock of Upper Triassic age W. of Menzies Bay on Vancouver Island and N. of Gowland Harbour on Quadra Island, British Columbia. The rock is black, finely laminated, fossiliferous, non-clastic, and consists chiefly of carbonaceous matter and microcrystalline quartz. The volborthite occurs along the laminae and is associated with abundant chalcocite, malachite, and brochantite, and minor amounts of cuprite, tenorite, azurite, calcite, cyanotrichite, connellite, and a hydrous copper sulfate.--D.O. Emerson.

3-3372. Ballman, A.A. THE GROWTH AND PROPERTIES OF COLORED QUARTZ: *Am. Mineralogist*, v. 46, no. 3/4, p. 439-446, 6 figs., table, March-Apr. 1961, 13 refs.

Ions were deliberately introduced into the quartz structure. The resulting color may explain the coloration of natural quartz. The crystals were grown in a high pressure steel autoclave. Quartz grown in sodium hydroxide or carbonate solutions does not incorporate Fe because acmite forms. Potassium carbonate solutions do not form acmite, and dark green crystals result. A carrier ion, such as Be, must be present to incorporate Fe^{+2} or Fe^{+3} into quartz. This results in light and dark green bands alternating with yellow bands, but coloration ceases after early growth stages. The apparent mechanism for the coloring is Fe going to Fe^{+2} and Fe^{+3} followed by formation of magnetite.--K.A. Riggs.

3-3373. Roy, Rustum. COMMENT ON "GROWTH AND PROPERTIES OF COLORED QUARTZ": *Am. Mineralogist*, v. 46, no. 3/4, p. 446-447, March-Apr. 1961.

Suggestions are presented which tend to modify the conclusions of Ballman [see abstract above]. One cannot extrapolate from the color of known compounds to the color produced by an ion in an interstitial or stuffing site. It seems most likely that a stuffed derivative is formed with Be ions replacing Si ions in the quartz. The Mn and Fe ions would occur in the stuffing sites to balance the charge.--K.A. Riggs.

3-3374. Lund, Ernest H. CHALCEDONY AND QUARTZ CRYSTALS IN SILICIFIED CORAL: *Am. Mineralogist*, v. 45, no. 11/12, p. 1304-1307, fig., Nov.-Dec. 1960, 7 refs.

A hollow sample of silicified coral from the Tampa formation at Ballast Point, Florida, is partitioned into 2 chambers. One contains small quartz crystals, the other is lined with colloform chalcedony. Both forms of quartz are thought to be deposited un-

der similar conditions from the dissolved silica of ground water. The crystals grew in a chamber with no visible opening. An opening provided solutions free access to the chalcedony-lined chamber.--D.O. Emerson.

3-3375. Murdoch, Joseph, and Robert A. Chalmers. ETTRINGITE ("WOODFORDITE") FROM CRESTMORE, CALIFORNIA: *Am. Mineralogist*, v. 45, no. 11/12, p. 1275-1278, 2 tables, Nov.-Dec. 1960, 8 refs.

The a-axis of the unit cell of ettringite is about 22.33 Å, twice the older value. Thus, "woodfordite," previously thought to be a new mineral, is ettringite, and the name must be withdrawn.--D.O. Emerson.

3-3376. Frondel, Clifford. TWO YTTRIUM MINERALS: SPENCITE AND ROWLANDITE: *Can. Mineralogist*, v. 6, pt. 5, p. 576-581, 3 tables, 1961, 13 refs.

Spencite is a new borate-silicate of Ca and Y, $(\text{Ca}, \text{Fe})_2(\text{Y}, \text{La})_3(\text{B}_3\text{Si}_{4.3}\text{Al}_{.7})(\text{O}, \text{OH}, \text{F}, \text{Cl})_{20}$ from a pegmatite in Cardiff township, Haliburton County, Ontario. Found as dark reddish brown to brownish black anhedral masses. Hardness 3 1/2, specific gravity 3.05. Metamict; isotropic with n near 1.630. When the mineral is heated at 325°C. the n increases to about 1.640 and the specific gravity to 3.20. At high temperatures the mineral decomposes before it recrystallizes, and X-ray diffraction data cannot be obtained. Spencite is related chemically to the minerals of the datolite group and may be isostructural with them. It is named after the Canadian mineralogist Hugh S. Spence.

A re-examination of the little known mineral rowlandite from Baringer Hill, Texas, establishes it as a valid species. Composition near $(\text{Y}, \text{Fe}, \text{Ce})_3(\text{SiO}_4)_2(\text{F}, \text{OH})$. Metamict; with n 1.704. Hardness 5 1/2, specific gravity 4.39; X-ray powder data are given for material recrystallized in N at 900°C. (with mean n 1.76, specific gravity 4.55).--Auth.

3-3377. Whelan, James A., and Henry Lepp. AN OCCURRENCE OF SAPONITE NEAR SILVER BAY, MINNESOTA: *Am. Mineralogist*, v. 46, no. 3/4, p. 430-433, fig., 2 tables, March-Apr. 1961, 3 refs.

This saponite occurs in amygdules and fracture zones in Keweenaw lava flows on the N. shore of Lake Superior. The fibrous habit of the saponite suggests that it formed by the alteration of fibrous zeolite.

Its composition is $\text{Mg}_{3.0}\text{Al}_{1.6}\text{Si}_{3.4}\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$, $X=0.6$, $\text{Ca}/2$. Its specific gravity is 2.10 ± 0.02 . The saponite is anisotropic and has a mean index of refraction of 1.49. The differential thermal analysis curve of this saponite is similar to curves of vermiculite because of 2 low temperature endothermic reactions at 175°C. and 310°C. Tables of chemical analysis and X-ray powder data are included. This saponite has an (001) d spacing of 15 Å.--K.A. Riggs.

3-3378. Vernon, R.H., and K.L. Williams. BERTRANDITE FROM MICA CREEK, QUEENSLAND: *Am. Mineralogist*, v. 45, no. 11/12, p. 1300-1303, fig., table, Nov.-Dec. 1960, 3 refs.

Bertrandite, $\text{Be}_4(\text{OH})_2\text{Si}_2\text{O}_7$, not previously re-

corded from Australia, occurs in a pegmatite from the Mica Creek area, near Mt. Isa, Queensland. The mineral, a hydrothermal alteration of beryl, is marginally replaced by sericitic mica with a 1-layer monoclinic structure. As aggregates and prismatic grains up to 2 mm. long, bertrandite comprises up to 50% of some specimens and is associated with beryl, muscovite with a 2-layer monoclinic structure, quartz and albite.--D. O. Emerson.

- 3-3379. Olsen, Edward J. SIX-LAYER ORTHO-HEXAGONAL SERPENTINE FROM THE LABRADOR TROUGH: *Am. Mineralogist*, v. 46, no. 3/4, p. 434-438, 2 tables, March-Apr. 1961, 11 refs.

The serpentine is from the E. side of the Labrador Trough NE. of the town of Knob Lake, Quebec-Labrador. It occurs in veins cutting a serpentine sill belonging to the epidote-amphibolite facies.

The material is too fine grained to yield useful optical data. Detailed tables of chemical and X-ray power data are given. The d value of (006) is 7.27 Å. An idealized structural formula is presented, and the significance of the data is discussed. The division between fibrous and platy serpentines may be at 0.6% R_2O_3 rather than at 4.5% as suggested by earlier work.--K. A. Riggs.

- 3-3380. RARE MINERAL FOUND IN MAN-MADE DIAMONDS: *Sci. News Letter*, v. 80, no. 2, p. 23, July 8, 1961.

Coesite, a high-pressure form of quartz, has been identified in man-made diamonds. Its discovery supports the theory that quartz in natural diamonds is secondary.--M. Russell.

- 3-3381. Clark, Thomas H., and John S. Stevenson. AUTHIGENIC BIOTITE IN THE UTICA SHALE AT L'EPHAPHIE, QUEBEC: *Geol. Assoc. Canada, Proc.*, v. 12, p. 97-104, 5 illus., map, graph, Dec. 1960, 2 refs.

Authigenic biotite is concentrated in the lower 6 in. of the Utica shale where it overlies the Trenton limestone in the bed of l'Achigan River at l'Epiphanie, Quebec. The rock is the normal euxinic facies, and, coincident with the authigenic biotite, is rich in *Leptobolus insignis*, fragments of a minute *Serpulites*, and scraps of graptolites. The biotite occurs as beautifully euhedral, pseudohexagonal, thin books that average 0.4 mm. in diameter and 0.1 mm. thick. The almost perfect pseudohexagonal euhedralism and lack of fraying of edges, the freshness and absence of any bleaching or alteration effects, and the presence of carbonaceous inclusions all suggest that the biotite is porphyroblastic and formed by authigenesis. It is probable that a 40 ft. basic sill, inferred from nearby outcrops and a borehole to underlie the contact at this point, provided the locally increased temperature responsible for the local development of biotite in these shale outcrops.--Auth.

- 3-3382. Brydon, J. E., and others. DIOCTAHEDRAL CHLORITE: *Can Mineralogist*, v. 6, pt. 5, p. 595-609, 4 figs., 3 tables, 1961, 29 refs.

The clay fraction from the surface soil of the Alberni soil series was found to consist predominantly of a high Al, dioctahedral chlorite. Its X-ray pattern showed a rather strong, sharp sequence of 14/n Å basal spacings and an (001) reflection which did

not change position and which increased in intensity when the specimen was heated at 550°C. The (hkl) reflections showed close similarities to those of cookeite, a lithium aluminum leptochochlorite.

Chemical analyses gave 40% SiO_2 , 34% Al_2O_3 , 4.5% Fe_2O_3 , 4.5% MgO , and 13% H_2O . The X-ray results and an Osthaus dissolution curve both resulted in a value of one tetrahedral Al per half cell. Calculation of an approximate structural formula gave $(Al_{3.2}Fe_{0.4}Ti_{0.1}Mg_{0.8})(AlSi_3)O_{10}(OH)_8 \cdot (K_{0.2}X_{0.2})$.

The clay fraction of the underlying material consisted of a 40% chlorite-60% montmorillonite, random mixed-layer assemblage. The evidence suggests that the Al chlorite in the surface soil was derived from this type of clay.--Auth.

- 3-3383. Tamura, T., and D. G. Jacobs. IMPROVING CESIUM SELECTIVITY OF BENTONITES BY HEAT TREATMENT: *Health Physics*, v. 5, no. 3/4, p. 149-154, 3 figs., 4 tables, June 1961, 8 refs. (not seen at AGI).

Selectivity for Cs was improved by heating montmorillonites to temperatures in the range of from 600 to 700°C. The optimum temperature depends on the saturating cation and bentonite type. For montmorillonite heated in this temperature range and at higher temperatures, clay-solution contact time was an important consideration. Sorption characteristics over a wide range of Cs concentration were investigated; the results suggested a multifunctional exchange reaction for the 600°C, Ca-montmorillonite and a simple mass action reaction for the oven-dried Ca-montmorillonite. The study of the influence of heating periods at 600°C for Ca-montmorillonite showed that longer heating periods resulted in a decreasing degree of initial sorption; however, Cs sorption gradually increased with solution clay contact time and eventually exceeded the Cs sorption of oven-dried samples.

These findings are significant for the understanding of clay mineral genesis and for application in ground disposal of radioactive waste (e.g., treated bentonite may serve as a substitute for illite which is used to remove Cs from process waste water).--Auth.

- 3-3384. Hoffmann, Reinhard W., and George W. Brindley. ADSORPTION OF ETHYLENE GLYCOL AND GLYCEROL BY MONTMORILLONITE: *Am. Mineralogist*, v. 46, no. 3/4, p. 450-452, March-Apr. 1961, 5 refs.

It is shown experimentally that ethylene glycol and glycerol are not preferentially absorbed by montmorillonite from an aqueous solution.

Suspensions of clay with varying concentrations of ethylene glycol or glycerol were equilibrated. After centrifuging, the organic content of the supernatant liquid was determined by dichromate oxidation. The clay-organic films were subjected to X-ray diffraction in a stream of dry air.

Complexes formed which contained 1 layer of water, 1 layer of organic material and/or 2 layers of organic material depending on the organic concentration of the solution adhering to the clay. The experiments show that ethylene glycol and glycerol form complexes after drying due to their low volatility compared with that of water.--K. A. Riggs.

- 3-3385. Mathews, David L. THE CLAY MINERALOGY OF SOME MOJAVE DESERT PLAYAS: Com-

pass, v. 38, no. 1, p. 28-38, map, graph, 2 tables, Nov. 1960, 10 refs.

Samples of sediments from Soda, Silver, Z (an unnamed playa), Silurian, Soggy, Emerson, and Mesquite lakes, [California], were analyzed by X-ray techniques to determine their mineral composition. Montmorillonite is the most abundant clay mineral, illite ranks second, and chlorite and/or kaolinite are present in minor amounts. Mica, quartz, feldspar, calcite, and halite are the dominant nonclay minerals present.

There are no variations in the groups of clay minerals present in the playa sediments although both areal and vertical variations in their relative abundances exist. The areal variations are a direct result of source while the vertical variations are interpreted to be the result of the formation of illite from montmorillonite by absorption of K under the influence of time and pressure. This vertical variation is expressed by a curve on which the illite/montmorillonite ratio is plotted against depth. On the basis of the illite/montmorillonite ratio a method of vertical zonation of playa deposits may be developed.--Auth.

3-3386. Sadler, A.G. THE MINERAL CONSTITUTION OF QUEENSTON SHALE: Can. Ceramic Soc., Jour., v. 29, p. 7-22, 1960.

The Queenston shale formation [Ordovician] is one of 3 main sources of raw material in Ontario for brick and tile manufacture. The formation is remarkably uniform, with deposits up to 400 ft. thick, which outcrops as a belt from Niagara Falls to Hamilton then N. to Bruce Peninsula; there are outcrops in eastern Ontario. The mineralogical composition of Queenston shale was studied by chemical analysis, D. T. A., and X-ray analysis. The major constituents are quartz, calcite, and a clay mineral or minerals, evidently a mixture of illite and chlorite. Samples of the shale from 3 different areas had identical mineralogical constituents, and the samples differed only in relative amounts of each component.--Courtesy Canadian Building Abstracts 136, June 1961.

3-3387. Schwartz, George M., and George A. Thiel. GUIDE TO THE MINERALS AND ROCKS OF MINNESOTA: 29 p., 2 figs., tables, Minneapolis, University of Minnesota, Dept. of Geology, and Minnesota Geological Survey, 1960.

3-3388. Mason, Brian H. TRAP ROCK MINERALS OF NEW JERSEY: New Jersey, Bur. Geology & Topography, Bull. 64, 51 p., 16 illus., fold. geol. map, table, 1960, 37 refs.

The trap rocks of New Jersey are intrusive into and interbedded with Triassic sedimentary rocks of the Newark series. In many places these rocks contain fine specimens of zeolites and other secondary minerals. This paper gives a brief description of the geological setting and paragenesis of these minerals, followed by individual descriptions. The following

minerals are described: actinolite, albite, allanite, analcime, apatite, anhydrite, apophyllite, aurichalcite, axinite, azurite, babingtonite, bornite, barite, calcite, chabazite, chalcocite, chalcopyrite, chlorite, chrysocolla, Cu, covellite, cuprite, datolite, dolomite, epidote, galena, glaucoberite, goethite, gmelinite, greenockite, gypsum, hematite, heulandite, hornblende, laumontite, malachite, mesolite, natrolite, opal, orpiment, orthoclase, pectolite, prehnite, pumpellyite, pyrolusite, quartz, scolecite, siderite, Ag, sphalerite, sphene, stevensite, stilbite, stilpnomelane, talc, thaumasite, thomsonite, tourmaline, ulexite. Occurrences of the following minerals are discredited or unconfirmed: allophane, aragonite, arfvedsonite, chloanthite, chrysotile, deweyite, epistilbite, erythrite, fluorite, genthite, kaolinite, magnesite, rhodochrosite, serpentine.--Auth.

3-3389. NOTES ON THE MINERALS OF FRANKLIN AND STERLING HILL, NEW JERSEY. By John S. Albanese: v. 1, no. 1, Oct. 1959- in progress, The Author, P.O. Box 221, Union, New Jersey.

A quarterly publication with notes and discussions on the geology, mineralogy, and minerals of this famous Zn deposit, written for the layman. Historical notes on the area and its mines are also included.--A. C. Sangreue.

3-3390. Shi, Ping-Chou, and N.I. Gorbunov. MINEROLOGICAL [SIC] COMPOSITION OF KRASNOZEMS DEVELOPED ON THE ELUVIUM OF IGNEOUS ROCKS: Pochvovedeniye, Soviet Soil Sci., in translation, 1959, no. 9, p. 1025-1030, 2 figs., 3 tables, pub. 1961, 14 refs.

Krasnozems developed on eluvium of granite and andesite-basalt show in their mineralogical composition features of similarity and difference. The highly disperse portion (<0.001 mm. in diameter) of both soils consists chiefly of minerals of the kaolinitic group. Krasnozems on andesite-basalt contains appreciable goethite, and gibbsite. Minerals of the kaolinitic group are found in significant quantities also in the coarser (than clay) fractions up to 0.1 mm. in diameter; in the krasnozems on andesite-basalt there are more of the clay minerals than in the krasnozems on granite.

The chemical composition of granites and andesite-basalts is markedly different, while the clay fractions of krasnozems developed on these parent rocks are more similar in composition. The difference consists in the higher content of K in the clay fraction of the krasnozems on granite. Owing to the difference of the parent materials the texture of the krasnozems on granite is coarser than the krasnozems on andesite-basalt. The cation adsorption capacity of the krasnozems and the fractions <0.001 mm. in diameter removed from them is fairly low.

The mineralogical composition of the krasnozems and fractions <0.001 mm. in diameter separated from them is controlled by different factors; the major role in this respect is played by the parent rock.--Auth. concl.

See also: Structural Geology 3-3243, 3-3245; Stratigraphy 3-3264; Geophysics 3-3321; Geochemistry 3-3332, 3-3338, Mineralogy 3-3387, 3-3388; Mineral Deposits 3-3445.

3-3391. Dodge, Natt N. LAND OF THE BLACK SHADOW: Natl. Parks Mag., v. 34, no. 159, p. 7-9, 4 illus., Dec. 1960.

A popular account is given of the probable volcanic eruption, in 1066 A.D. which resulted in Sunset Crater, northern Arizona. The crater features include a symmetrical cinder cone, basalt lavas, extinct fumaroles, "squeeze-ups," and cinder dunes.--M. Russell.

3-3392. Chesterman, Charles W. PLUTONIC ROCKS: California, Div. Mines, Mineral Inf. Service, v. 14, no. 6, p. 1-8, 5 illus., 3 secs., June 1961, 11 refs.

Three main rock types constitute the earth's crust: igneous, metamorphic, and sedimentary. The California Division of Mines in 1953 (Mineral Information Service, v. 6, no. 7, p. 1-5) published a general description of the volcanic rocks, their mode of occurrence, and physical and chemical features. "Plutonic rocks" is the second in this series and treats the general features of this very important group of igneous rocks: their forms and modes of occurrence, composition - mineralogical and chemical textures, structural features, origin, classification, types, distinguishing features of plutonic and volcanic rocks, and useful minerals and minerals derived from plutonic rocks.--Auth.

3-3393. Chodos, Arthur A., and Celeste G. Engel. FLUORESCENT X-RAY SPECTROGRAPHIC ANALYSES OF AMPHIBOLITE ROCKS AND CONSTITUENT HORNBLENDES (In: Mueller, William H., ed. Advances in X-Ray Analysis, Volume 4: p. 401-413, 9 figs., 4 tables, New York, Plenum Press, 1961) 6 refs.

Fluorescent X-ray spectrographic analyses have been made for the oxides Fe_2O_3 , CaO , MgO , K_2O , TiO_2 , and MnO on samples of amphibolite rock. In addition, the above oxides and SiO_2 and Al_2O_3 have been determined in a suite of constituent hornblendes from these rocks.

Classical wet chemical analyses of materials of the same mineralogical composition as the samples are used to establish the working curves. This eliminates the necessity for internal standardization or other treatment of the samples. The only sample preparation involves extremely fine grinding before analysis.

Precision of the analyses is equivalent to, or better than, that achieved by wet chemical methods.--Auth.

3-3394. Harry, W. T., and C. H. Emeleus. MINERAL LAYERING IN SOME GRANITE INTRUSIONS OF S. W. GREENLAND: Greenland, Geol. Undersøgelse, Misc. Papers no. 27, 10 p., 10 figs., 1960, 9 refs.; reprinted from: International Geological Congress. 21st Copenhagen, 1960. Report, Pt. 14, p. 172-181.

Original paper was abstracted as GeoScience Abstracts 3-2355.

3-3395. Kapp, Hans E. A PETROGRAPHIC COMPARISON OF A TERTIARY ALKALINE IGNEOUS

COMPLEX IN NORTHEASTERN GREENLAND WITH THE MONTEREGIAN HILLS OF EASTERN CANADA: Can. Mineralogist, v. 6, pt. 5, p. 582-594, 3 figs., 1961, 9 refs.

A tertiary, alkaline, igneous complex occurs in eastern Greenland near the Atlantic coast at approximately 72°N. latitude. The magma intruded a sequence of flat-lying, unmetamorphosed, arenaceous sediments ranging from Carboniferous to late Cretaceous in age. Thermal, metasomatic, and mechanical contact effects are very small.

Igneous rock types range from pyroxenite and peridotite through gabbro and monzonite to calc-alkali syenite, alkali syenite, nepheline syenite, and alkali granite. The basic types show with titanite, titaniferous hornblende, Ti-rich biotite, and plagioclase as major constituents, and with residual alkali feldspar a clearly essexitic character. Age sequence from basic to acid types is well proved by inclusions and apophyses. Both intrusions of separate, distinct magmas as well as differentiation in situ took place. The general trend of the Niggli-values in the variation diagram and the development along the MF line in a QLM triangle (atlantic differentiation) correspond well with the genetic sequence. Various kinds of volcanic and subvolcanic breccias are genetically and spatially related to the intrusives (mainly to the syenites) and prove the hypabyssal, shallow character of the latter.

Leucocratic dikes of mainly syenitic composition are considered to be comagmatic derivatives of the acid intrusions.

Basic dikes and sills are extremely numerous and comprise both alkali basalts and lamprophyres. Yet it is not possible to evaluate to what extent they may be related to the local alkaline intrusions or to the regional Greenlandic (Brito-Arctic) basalt cycle.

Pneumatolytic-hydrothermal alteration of both intrusive and sedimentary rocks, and deposition of disseminated sulfides and oxides are conspicuous throughout the whole complex. Economic deposits of molybdenite and wolframite of this phase are associated with the granite in the western part of the complex, while galena and sphalerite-rich quartz veins were found N. and S. of it.

The results of spectrochemical trace element study in minerals and rocks from the western part of the complex are discussed in detail.

Facts which are true for both the Greenland and the Monteregian igneous complex and which prove their close relation are: alkaline character (essexite-syenite), mineralogical paragenesis, trend of differentiation, age sequence, comagmatic dike-swarms, formation of volcanic and subvolcanic breccia, near-surface intrusion level, small thermal, metasomatic, and mechanical effect against the wall-rock, and atectonic emplacement.--Auth.

3-3396. Gittins, John. NEPHELINIZATION IN THE HALIBURTON-BANCROFT DISTRICT, ONTARIO, CANADA: Jour. Geology, v. 69, no. 3, p. 291-308, 4 figs., 11 tables, May 1961, 19 refs.

New field and chemical data are presented for the nepheline-bearing gneisses of the Haliburton-Bancroft district. Evidence has already been presented to show that some of the nepheline-bearing rocks of the region are igneous rocks that retain their original igneous texture. The nepheline-bearing gneisses of the region are of 2 kinds: regionally metamorphosed (nephelinized) rocks and regionally metamorphosed igneous rocks. Examples of nephelinized skarn and nephelinized marble from Glamor-

gan and Monmouth townships are described, and an attempt is made to interpret the chemistry of nephelinization in the light of these examples. Gummer and Burr concluded that the nepheline gneisses were derived from biotite - and hornblende-bearing paragneiss by metasomatism (nephelinization), the agents of this metasomatism being derived probably from granitic magma. The conclusion is reached in the present study that the gneisses thought by Gummer and Burr to be original paragneiss represent an arrested stage of nephelinization, and that Si, Al, Fe, Na, and K were added to the host rocks during metasomatism. It is emphasized that nephelinization is a series of related processes, rather than a single process, that leads generally but not inevitably to a feldspathoidal assemblage. The source of the metasomatizing agent appears to be feldspathoidal magma, the former existence of which is known from the presence of igneous nepheline-bearing rocks of magmatic origin previously referred to. Such an origin alleviates the difficulties inherent in deriving the agents of nephelinization from a granitic or any other source. The nepheline-bearing pegmatites of the region are thought to be of igneous rather than metasomatic origin.--Auth.

3-3397. Hoyt, Carroll L. THE HAMMOND SILL - AN INTRUSION IN THE YAKIMA BASALT NEAR WENATCHEE, WASHINGTON: Northwest Sci., v. 35, no. 2, p. 58-64, 2 illus., map, May 1961, 4 refs.

Stratigraphic study of the Yakima basalt in Douglas County has led to the discovery of a thick and extensive sill near the community of Hammond, 10 mi. SE. of Wenatchee. Similar, but smaller, sill-like intrusions occur near the same stratigraphic horizon at

several other localities in the county. These may be parts of the Hammond sill, or several sills may be represented, each having been emplaced along the same zone of weakness.

While the present study has not been carried beyond the stage of field reconnaissance, it seems worthwhile to put on record the largest of the intrusions, which is excellently exposed along the highway at Rock Island Dam and in a nearby scarp overlooking the community of Hammond on the E. side of the Columbia River.

At its type locality the Hammond sill is more than 400 ft. thick. It can be traced northward along both sides of Rock Island Creek for several miles. To the E., excellent exposures of the sill occur in the lower part of Moses Coulee. There it forms low cliffs for several miles along the Coulee floor as far northeastward as Palisades, approximately 12 mi. from Hammond. D. E. Walcott also recognized the unit as far S. as Trinidad on the Columbia River, and H. A. Coombs independently discovered what is probably the same sill in the Laurel Hill scarp several miles W. of Hammond. The minimum areal extent is therefore in excess of 100 sq. mi.

Because stratigraphic relationships appear relatively consistent along much of the western scarp between Wenatchee and Bridgeport, there is good reason to suspect that the Hammond sill is present over a large part of western Douglas County. If subsequent study supports this possibility, a sill covering some 700 sq. mi. and ranking with the largest known sills in the world will have been outlined. The importance of such knowledge in understanding the distribution and emplacement of surface flows in this portion of the Columbia Plateau is readily apparent.--From auth., p. 58, 64.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 3-3226; Stratigraphy 3-3249; Geochemistry 3-3339; Mineralogy 3-3381, 3-3387; Engineering Geology 3-3540.

3-3398. Colby, Bruce Ronald, and D. W. Hubbell. SIMPLIFIED METHODS FOR COMPUTING TOTAL SEDIMENT DISCHARGE WITH THE MODIFIED EINSTEIN PROCEDURE: U.S. Geol. Survey, Water-Supply Paper 1593, 17 p., 8 pls. (in pocket), table, 1961, 5 refs.

A procedure was presented in 1950 by H. A. Einstein for computing the total discharge of sediment particles of sizes that are in appreciable quantities in the stream bed. This procedure was modified by the U. S. Geological Survey and adapted to computing the total sediment discharge of a stream on the basis of samples of bed sediment, depth-integrated samples of suspended sediment, stream-flow measurements, and water temperature. This paper gives simplified methods for computing total sediment discharge by the modified Einstein procedure. Each of 4 nomographs appreciably simplifies a major step in the computations. Within the stated limitations, use of the nomographs introduces much less error than is present in either the basic data or the theories on which the computations of total sediment discharge are based. The results are nearly as accurate mathematically as those that could be obtained from the longer and more complex arithmetic and algebraic computations of the Einstein procedure.--Auth.

3-3399. Romanova, Mary A. SPECTRAL BRIGHTNESS OF WEST TURKMENIAN JURASSIC ARENA-

CEOUS ROCKS AND ITS CORRELATION WITH ROCK PETROGRAPHY AND SEDIMENTARY ENVIRONMENT: Jour. Geology, v. 69, no. 3, p. 261-278, 5 figs., 14 tables, May 1961, 12 refs.

The spectral brightness of W. Turkmenian arenaceous rocks can be used to correlate petrography and facies. Perhaps spectral brightness could be used as a petrographic parameter in reconstructing the environments of sedimentation.--Auth.

3-3400. Clark, Don R. PRIMARY STRUCTURES OF THE HALFWAY SAND IN THE MILLIGAN CREEK OILFIELD, BRITISH COLUMBIA: Alberta Soc. Petroleum Geologists, Jour., v. 9, no. 4, p. 109-130, 15 figs., 3 pls., Apr. 1961, 24 refs.

Large and small scale primary structures determine the Halfway [Triassic] to be a barrier sand bar. Subaqueous solifluction is the mechanism of emplacement of the mottled and brecciated overlying shale. Graded bedding of the underlying shale suggests deposition from small-scale turbidity currents. Photographs of primary cross bedding of 65° and 85°, and of mottled shale, are included.--Auth.

3-3401. Smith, Ned M., and others. BRECCIA AND PENNSYLVANIAN CAVE FILLING IN MISSISSIPPIAN ST. LOUIS LIMESTONE, PUTNAM COUNTY, INDIANA: Jour. Sed. Petrology, v. 31, no. 2, p. 275-287, 7 figs., June 1961, 8 refs.

A limestone breccia and several bodies of shale

and sandstone in Mississippian St. Louis limestone were discovered in a quarry opened during the summer of 1959 in the SE1/4NW1/4 sec. 15, T. 15N., R. 4W., Putnam County. A small mass of sandy limestone conglomerate overlay part of the breccia. Nearly all these bodies have been removed in quarrying.

The breccia and the shale-sandstone masses appear to have originated from 2 separate geologic processes which occurred at 2 different times. The origin of the breccia is in doubt because not enough critical evidence is available to prove conclusively any single origin. The authors believe, however, that the breccia probably is the product of a submarine rock slump during St. Louis time which was triggered by the tectonic activity that initiated early movements along the Mt. Carmel fault. Other possible origins, such as solution of evaporites accompanied by collapse of overlying rock or formation of caves in a karst terrain followed by roof collapse, are not supported by the evidence observed.

The shale-sandstone bodies are believed to be rocks of Pennsylvanian age which were deposited in caverns developed during the Mississippian-Pennsylvanian erosion interval. The limestone conglomerate probably is of the same age as the shale-sandstone bodies.--Auth.

3-3402. Williamson, Iain A. SPRING DOMES DEVELOPED IN LIMESTONE: Jour. Sed. Petrology, v. 31, no. 2, p. 288-291, 2 figs., table, June 1961, 7 refs.

A group of dome-shaped features in lower Carboniferous (Mississippian) limestones in NW. Lancashire, England, are described. Radial jointing is crudely developed, and many of the features are characterized by a central crater. No such features have been previously described; they are interpreted as nondiastrophic structures developed by the expulsion of water from an underlying source. The descriptive term "spring-dome" is suggested for the structures.--Auth.

3-3403. Carozzi, Albert V. DISTORTED OOLITES AND PSEUDOOLITES: Jour. Sed. Petrology, v. 31, no. 2, p. 262-274, 13 figs., June 1961, 11 refs.

Distorted oolites and pseudoolites are relatively rare occurrences in the geological column. They have been described in oolitic Fe ores, phosphorites, limestones, argillaceous, and sideritic deposits. The shapes created by the distortion processes are very characteristic and independent from the mineralogical composition. They illustrate a complete graduation from plastic deformation to the rupture of rigid bodies. The distortion, which is localized in pockets or affects only isolated individuals, has always preceded the deposition of the cement and compaction wherever the latter has been active. The conclusion is reached that the distortion was generated during sedimentation in agitated conditions and resulted from the reciprocal impacts among oolites or pseudoolites at different stages of diagenetic induration.--Auth.

3-3404. Schreiber, Joseph F. SEDIMENTATION SURVEY OF LAKE CARL BLACKWELL, PAYNE AND NOBLE COUNTIES, OKLAHOMA: Shale Shaker, v. 11, no. 6, p. 11-17, 6 illus., 2 maps, 6 figs., Feb 1961, 5 refs.

This report gives the results of a sedimentation

survey of Lake Carl Blackwell made during June to mid-Oct. 1958. The survey was made chiefly to determine the amount and rate of sedimentation and the distribution of sediment in the lake.

The lake consists of a main body approximately 5 by 3/5 mi. and 6 smaller arms. A rolled earth fill dam and concrete spillway are located at the E. end. Sediment deposits consist of silt and clay with some sand. The thickest deposits are found at the western end and in the heads of the larger arms. The original capacity has been reduced 6.46% in 20 1/2 years. At the present rate of sedimentation the expected ultimate life is approximately 300 years, but the remaining useful life is probably closer to 180 years. Shoreline erosion has been most active in the soft clay shales.--C.E. Branham.

3-3405. Fisk, Harold N. RECENT MISSISSIPPI RIVER SEDIMENTATION AND PEAT ACCUMULATION (In: Congrès pour l'Avancement des Études de Stratigraphie et de Géologie du Carbonifère. 4th, Heerlen, 1958. Compte Rendu, v. 1, p. 187-199, 8 figs., Maastricht, Netherlands, Éditions "Ernest Van Aelst," 1960) 21 refs.

The Mississippi River has occupied and abandoned several courses in the past several thousand years while constructing its 150-mi.-wide deltaic plain in coastal Louisiana. Each new course lengthened gulward as sediments, carried through widely diverging river-mouth distributaries, advanced the shoreline and increased the marshland area. In lengthening, each main channel occupied and enlarged a succession of favored distributaries and abandoned others, plugging their channels with sandy sediment. The abandoned distributaries vein the marshlands and mark progressive stages in course emplacement. Compaction and regional subsidence have combined to depress the marshlands, with resultant burial of distributary natural levees and development of tidal channels, lakes, and bays in interdistributary marshlands. Widespread peats occurring in these interdistributary marshlands are "split" by distributary natural-levee deposits which they both underlie and overlie. This relationship indicates contemporaneous organic and inorganic sedimentation and continued organic accumulation accompanying levee sinking after distributary abandonment. Distributary channel fillings form deep "wants" through the peat, and shallow tidal channels, developed during marshland destruction, are true "wash-outs." Locally, near New Orleans, peats attain a thickness of 20 ft. Radiocarbon dates show that they began to form approximately 3,000 years ago and have accumulated at a rate averaging 1 ft. per 300 years.--Auth.

3-3406. Shepard, Francis P., and Ruth Young. DISTINGUISHING BETWEEN BEACH AND DUNE SANDS: Jour. Sed. Petrology, v. 31, no. 2, p. 196-214, 17 figs., 3 tables, June 1961, 20 refs.

The comparison of adjacent pairs of beach (largely foreshore) and dune sands from 74 localities of world-wide distribution has shown that it is generally possible to distinguish between the 2, particularly if there are predominant onshore winds. The dune sands are usually rounder than the adjacent beach sands, have a larger silt content, and this silt has a higher content of heavy minerals. The beach foreshores, on the other hand, usually contain more shells and other calcareous organisms than the dunes. There is also some reason to believe that mica content is greater in beach foreshores than in

adjacent dunes. The sand of beach berms appears to be intermediate in most respects between that of the foreshores and dunes.

The areas where beaches and dunes are most difficult to distinguish are those where there are long-shore, extremely variable, or offshore winds. In such localities it is thought that the dune sands are blown back onto the beaches causing intermixture, and that in some cases the dunes are derived from sources other than from the adjacent beach. The best results in separating the 2 environments have come from beaches of the W. coast of the United States and Baja California where onshore winds predominate.

It is suggested that the chief reason for the differences between dune and beach sands is that the wind picks up from the beaches more of the rounder grains than of the flat and angular grains. There is no reason to believe that the grains are rounded appreciably by the wind in transit to the dunes. Nor does there appear to be any evidence from these comparisons that the dune grains become frosted. The greater quantity of heavy minerals in the dune silt fraction may be caused by removal by the wind of the light minerals.--Auth.

3-3407. Milton, W. Bryan. ACOUSTICAL SAND: *Compass*, v. 38, no. 2, p. 99-105, Jan. 1961, 27 refs.

Sands possessing acoustical properties have been described from all over the world. The sands have been given many different names; for the sake of simplicity and organization, the writer proposes the name "acoustical sand."

Acoustical sand is found only in 2 types of environment: on beaches, and desert sand dunes. It is composed almost entirely of clean, well-rounded quartz grains and must be dry and in motion to emit sound. Descriptions of the noise range from deafening siren shrieks in the Arabian Desert to barks of a dog on a beach in the Hawaiian Islands.

Several theories concerning the origin of the sounds have been advanced. One investigator considered it due to reverberations upon a gliding plane within the dune. After extensive laboratory tests, other writers concluded that the noise was caused by vibration of air films around the particles. Still another suggests that the sounds are due to friction caused by a thin film of salts on the surface of the grains acting similar to resin on a violin bow. After extensive laboratory investigations another postulated that the noise was due to some property of the individual grains, probably their molecular structure.--Auth.

3-3408. Dawson, K.R. THE ORIGIN OF THE HOLLEFORD CRATER BRECCIA: *Can. Mineralogist*, v. 6, pt. 5, p. 634-646, 5 figs., 2 tables, 1961, 9 refs.

This paper reports the results of a petrographic and geochemical study undertaken to evaluate the possibility that the polymict breccia discovered in drill core from Holleford, Ontario, is the product of meteorite impact. The breccia lies in a bowl-shaped depression on the Proterozoic (Grenville) land surface and is overlain by Paleozoic rocks. The coarse fragmental constituents have been derived from the Proterozoic rather than the Paleozoic rocks. The arenaceous fraction of the breccia exhibits a very limited variety of mineral constituents, wholly of local derivation, and grain forms which indicate little or no transportation. Clay minerals from the matrix of the

breccia are typical of normal sediments. No meteoritic materials have been identified microscopically, and the Ni content of the breccia is only slightly above average for sedimentary rocks. The bowl-shaped form of the breccia, as indicated by diamond drilling and geophysical data reported by Beals, is the principal criterion favoring genesis by meteorite impact. Other data neither refute nor confirm this hypothesis.--Auth.

3-3409. Hiss, W.L. THE ORIGIN OF CHERT, AN INVESTIGATION OF THE LITERATURE: *Compass*, v. 38, no. 1, p. 3-17, 13 figs., Nov. 1960, 55 refs.

The literature on the origin of chert is reviewed. There are 2 broad concepts of chert formation: 1) that formation is contemporaneous with deposition, and 2) that formation is due to post-depositional replacement of a host rock, which is usually limestone. The known chemistry of silica-water solutions sets rigorous limits within which a geologist must work when arriving at conclusions from field and petrographic evidence. However, the present knowledge of the chemistry of silica does not offer a ready means for the determination of the origin of siliceous sediments, and therefore geologic evidence must still decide which of the possible methods of chert formation has been dominant in any particular occurrence.--Auth.

3-3410. Richter, Robert W. THE ORIGIN AND ENVIRONMENTAL SIGNIFICANCE OF GYPSUM AND ANHYDRITE: *Compass*, v. 38, no. 2, p. 79-90, fig., Jan. 1961, 27 refs.

Gypsum and anhydrite usually occur in association with other evaporites, leading to the belief that calcium sulfate is precipitated from sea water. The geochemistry of sea water is reviewed, as are the various geological theories attempting to account for the thick deposits of gypsum and anhydrite found throughout the world.

General conclusions reached are that deposition occurs in restricted arms of the sea with continuous inflowing surface currents of slightly concentrated solution and continuous return flows at depth of concentrated brine. The effect of radiant heat is suggested as a controlling factor in determining the character of the calcium sulfate deposited. However, the opposing idea that primary anhydrite is probably not directly precipitated from sea water is also discussed, with no definite conclusion reached on this point.--Auth.

3-3411. Middleton, G.V. EVAPORITE SOLUTION BRECCIAS FROM THE MISSISSIPPIAN OF SOUTHWEST MONTANA: *Jour. Sed. Petrology*, v. 31, no. 2, p. 189-195, 3 figs., June 1961, 19 refs.

Zones of breccia within the Madison group of SW. Montana consist of very poorly sorted angular fragments of calcilutite or silty limestone, which are set in a fine-grained matrix of crushed "rock-flour" and cemented by calcite. In places where the matrix was silty or sandy it weathers yellow-brown and contains abundant authigenic quartz crystals. The breccias are confined stratigraphically to zones which may be correlated with evaporites in subsurface sections. The upper contacts of the breccia zones are indistinct, but the lower contacts are well defined; in some localities, brecciation occurred in place with little displacement of the fragments.

The brecciation resulted from the collapse and

crushing of nonsoluble strata after the solution by ground water of beds of evaporite.--Auth.

3-3412. Ross, Charles A., and Shinya Oana. LATE PENNSYLVANIAN AND EARLY PERMIAN LIMESTONE PETROLOGY AND CARBON ISOTOPE DISTRIBUTION, GLASS MOUNTAINS, TEXAS: Jour. Sed. Petrology, v. 31, no. 2, p. 231-244, 4 figs., 2 pls., June 1961, 16 refs.

The environment of deposition and diagenetic changes of some of the Late Pennsylvanian and Early Permian limestones of the Glass Mountains are closely reflected in their field relations and in their texture and particle composition as determined by thin section investigations.

From analysis of stable C isotopes the fine-grained, light-colored, algal limestones indicative of an oxidizing environment have distinctly positive δC^{13} values, whereas fine-grained, dark-colored fetid limestones indicative of reducing environments have markedly negative δC^{13} values. The coarse grained limestones having abundant sparry calcite cement have δC^{13} values near zero, that is, a C^{13}/C^{12} ratio near the standard, Chicago PDB, a belemnite. These C^{13} values suggest that the source of the sparry calcite cement is at least in part from CO_2 produced by methane fermentation of organic material in the substrata.--Auth.

3-3413. Maxwell, W.G.H., and others. CARBONATE SEDIMENTATION ON THE HERON ISLAND REEF, GREAT BARRIER REEF: Jour. Sed. Petrology, v. 31, no. 2, p. 215-230, 8 figs., June 1961, 5 refs.

A survey of the reef flat and sand cay of the Heron Island reef [off Queensland, Australia] has shown that the bulk of the surface material consists of skeletal detritus derived largely from coral and algae. Oolitic and other accretionary material is absent. The distribution of the skeletal sand is controlled by the faunal, physiographic, and current patterns. Several sand facies may be distinguished on the basis of textural and compositional variation, the diagnostic constituents in the different facies frequently being in minor amounts. Granulometric analyses reflect the close relationship between textural variation and such factors as physiography and currents. Grain orientation measurements reflect this same relationship.--Auth.

3-3414. Berger, A.R. ON A RECENT VOLCANIC ASH DEPOSIT, YUKON TERRITORY: Geol. Assoc. Canada, Proc., v. 12, p. 117-118, Dec. 1960, 6 refs.

The volume of a pumiceous ash deposit in the Teepee Lake area, southern Yukon Territory, is estimated to be about 6 cu.mi.--Auth.

3-3415. Hülsemann, Jobst, and K.O. Emery. STRATIFICATION IN RECENT SEDIMENTS OF SANTA BARBARA BASIN AS CONTROLLED BY ORGANISMS AND WATER CHARACTER: Jour. Geology, v. 69, no. 3, p. 279-290, 7 figs., 2 pls., 3 tables, May 1961, 13 refs.

Santa Barbara basin is one of the most interesting of the 14 submarine basins off southern California because of the high organic productivity of its surface waters and the low O content of its bottom waters. In its deep central area the sediments contain hydrogen sulfide and few benthic animals. Long cores of

the sediment show that, during the past, there were many alterations between periods when benthic animals were rare and periods when they were relatively abundant. During periods of rare benthic animals, the wintertime deposits of detrital silts and clays and the springtime deposits of diatoms were preserved as laminae, a type of varve. During periods of more abundant benthic animals, the laminae became so thoroughly mixed by burrowing and other animal activities that homogeneous deposits were produced. Interrupting both kinds of deposits are silt and clay layers, formed by turbidity currents which spread throughout the basin but which seem to have had little effect on benthic life.--Auth.

3-3416. Wigley, Roland L. BOTTOM SEDIMENTS OF GEORGES BANK: Jour. Sed. Petrology, v. 31, no. 2, p. 165-188, 12 figs., 5 tables, June 1961, 20 refs.

A survey of Georges Bank [New England continental shelf] bottom sediments was undertaken to provide basic data for use in studying the relationships between substrate composition and the occurrence of benthic animals, especially those which are common foods of fishes.

Particle size composition is the principal sediment character that was studied. Six statistical measures of particle size composition are given in order to designate the main features of the size-frequency distribution of each sample. These measures are: median diameter, mean diameter, coefficient of sorting, kurtosis, and 2 measures of skewness. In addition to these parameters, organic content, shell content, color, and textural classifications are included. In the presentation and discussion of the data, special emphasis is given to the geographic distribution of the various sediment constituents and particle size composition.--Auth.

3-3417. Price, W. Armstrong, and Louis S. Kornicker. MARINE AND LAGOONAL DEPOSITS IN CLAY DUNES, GULF COAST, TEXAS: Jour. Sed. Petrology, v. 31, no. 2, p. 245-255, 6 figs., June 1961, 16 refs.

Thin, light-weight valves of *Mulinia lateralis*, a lagoonal clam, are found evenly and naturally interbedded in clay at 8 to 33 ft. above mean sea level in a clay dune of the mainland shore of Laguna Madre, the coastal lagoon of southwestern Texas. The dune is on the lee shore of a small embayment where the shells seem to have been carried from the parent lagoon by waves and currents and strewn on a mud flat normally barren of subaqueous invertebrates. The shells were then redistributed by wind over the dune. Previously, the only fossils reported from clay dunes have been Foraminifera and food animals and shells of aboriginal camp sites.

The environment of the occurrence is briefly described, with a review of the origin and development of clay dunes. An irregularly distributed layer of organic and inorganic flotsam deposited on the clay dunes by storm waves is also described, and it is concluded that the *M. lateralis* shells were not similarly deposited.--Auth.

3-3418. Fuller, A.O. SIZE DISTRIBUTION CHARACTERISTICS OF SHALLOW MARINE SANDS FROM THE CAPE OF GOOD HOPE, SOUTH AFRICA: Jour. Sed. Petrology, v. 31, no. 2, p. 256-261, 3 figs., June 1961, 3 refs.

The results of detailed mechanical analyses of

shallow marine sediments collected around the coasts of the Cape of Good Hope are presented. The sediments are quartz sands containing 20 to 40% shell fragments. Weight percentage cumulatives plotted on arithmetic-probability paper after phi-transformation show up to 4 modes. The cumulatives can in all cases be expressed in terms of log-normal components, and it has been found that the points of inflexion separating the 3 principal modes persistently occur at about 0.8 and 2 phi. The shapes of the

cumulatives and positions of the inflexion points are not obviously related to shell content, analyses of acid leached sands giving the same results (with trivial exception) as their unleached counterparts. Consideration of the significance of the 0.8 and 2 phi inflexion points in terms of various factors which could induce polymodality, leads to the conclusion that the Stokes-Impact formulae account for the 2 phi point and mixing of the suspension and traction loads is responsible for the 0.8 phi point.--Auth.

11. GEOHYDROLOGY

See also: Geochemistry 3-3343 through 3-3346; Sedimentary Petrology 3-3398; Fuels 3-3463.

3-3419. Scheidegger, Adrian E. **THE PHYSICS OF FLOW THROUGH POROUS MEDIA**: rev. ed., 313 p., 46 figs., 7 tables, New York, Macmillan, 1960, approx. 1,650 refs.

The book grew out of the need felt by research workers to obtain an idea of the present state of knowledge about the physical principles of hydrodynamics in porous media. The guiding principles in the selection of material for this book were as follows: 1) Emphasis was laid on the general physical aspects of the phenomena rather than on particular cases applicable for example, to special engineering problems. 2) Of the many solutions available for some of the basic differential equations, only one was chosen for presentation in each case. The theory of differential equations is a well-established discipline of mathematics and has been considered of interest in the present context only if pertinent physical concepts were revealed. 3) The theoretical aspects have perhaps been stressed somewhat more than the experimental ones. However, descriptions of such procedures which enable one to determine theoretical "constants" have always been supplied in order to establish the proper logical sequence.

Little of the material contained in the first edition (1957) has been rewritten but many substantial additions have been made. The chief of these are the expansion of the chapter on multiple phase flow into 3 chapters, one dealing with elementary displacement theory, the second with immiscible displacement, and the third with miscible displacement. In the chapter on elementary displacement theory, the description of instability phenomena (fingering) may be of considerable interest, and in the chapter on miscible displacement, the theory of dispersion phenomena is of note.

Throughout the book, numerous new references have been added and the contents have generally been brought up to date. Many sections, such as that on deformation of porous media, that on wettability, and that on flow through compressible porous media have been expanded to give a clearer view of these topics. Similarly, a section on thermal effects in porous media (such as the onset of convection currents) has been added because of their recent importance in connection with problems of disposal of atomic wastes.--From pref. to 1st & 2nd eds.

The 10 parts deal with the following topics: porous media, fluids, hydrostatics in porous media, Darcy's law, solutions of Darcy's law, physical aspects of permeability, general flow equations, elementary displacement theory, immiscible multiple phase flow, miscible displacement.

3-3420. Richardson, E. V., and others. **SONIC DEPTH SOUNDER FOR LABORATORY AND FIELD**

USE: U. S. Geol. Survey, Circ. 450, 7 p., 4 figs., 1961.

An electronic device capable of mapping the streambed configuration under dynamic conditions is described. The sonic depth sounder was designed primarily for use in a hydraulics laboratory in research, but it has potential use as a field instrument in alluvial channels.--U. S. Geol. Survey.

3-3421. United Nations, Water Resources Development Centre. **LARGE-SCALE GROUND-WATER DEVELOPMENT**: 84 p., New York, 1960, refs.

The first of a series of studies to be jointly undertaken by the various United Nations organizations participating in the activities of the United Nations Water Resources Development Centre.

The study is divided into an introduction and 5 chapters, supplemented by annexes of more technical and detailed nature and a glossary. The introduction delineates the study, with reference to experience gained in technical assistance in the light of advances in ground water technology and current development. Chap. 1 sets out some basic considerations relating to ground-water use and deals in turn with economic factors, quantity and quality of water, allocation of ground-water supplies, effective use and conservation, and some social implications. Chap. 2, on stages of ground-water development, covers the range from hydrogeological investigation to maintenance. Economic and financial aspects are the subject of Chap. 3, which reviews the elements of costs, the prospective benefits, and the types of financing. Chap. 4 considers the role of governments and the framework for organization and administrative questions relating to staff and other requirements. Chap. 5 discusses concepts of ground-water rights and other matters of ground-water legislation.--From foreword.

3-3422. Morris, J. M., Jr., and others. **INTRUSION OF SALT WATER INTO GROUND WATER BASINS OF SOUTHERN ALAMEDA COUNTY**: California, Dept. Water Resources, Bull. no. 81, 44 p., 2 figs., 7 pls., Dec. 1960 (not seen at AGI).

Southern Alameda County, in Santa Clara Valley near San Francisco, is 1 of 9 coastal ground-water basins in California subject to degradation by sea-water intrusion. Sea-water intrusion was first noted in 1920 in the Newark aquifer, a shallow unconsolidated Quaternary deposit. Continued heavy extractions of ground water from this aquifer, during the period 1920-1928, established a hydraulic gradient sloping away from San Francisco Bay. This favorable gradient allowed further landward encroachment of saline water from the outcrop area of the aquifer on the Bay

floor. By 1928, extensive areas of ground water in this aquifer were unsuited for irrigation, forcing landowners to develop wells in the deeper Centerville aquifer. In 1950, sea water was noted in a 100-acre area in the Centerville aquifer, rapidly expanding to 2,800 acres in 1956 and to 3,000 acres in 1959. Heavy pumpage in the Centerville aquifer created a head differential with the overlying Newark aquifer, thus allowing saline water to move downward through: 1) breaks in the confining clay member between the 2 aquifers; 2) through slow percolation through the confining clay member; and 3) through spilling or downward cascading of saline waters in improperly constructed, defective or abandoned water wells.

By 1959, saline intrusion was noted in a restricted area of the Fremont aquifer, an extensive aquifer below the Centerville aquifer. This encroachment represents the first intrusion into the deeper fresh-water-bearing deposits which underlie the entire area.

The following corrective measures have been recommended: a) import supplemental water to equalize ground water supply and extractions; b) continue the search for and the proper sealing of problem wells which may develop; c) adopt and enforce suitable standards for water well construction and for sealing of abandoned wells.--R. C. Richter.

3-3423. Hembree, Charles H., and Frank H. Rainwater. CHEMICAL DEGRADATION ON OPPOSITE FLANKS OF THE WIND RIVER RANGE, WYOMING: U.S. Geol. Survey, Water-Supply Paper 1535-E, 9 p., 3 figs., 2 tables, 1961, 4 refs.

The rate of degradation by solution on the NE. flank of the Wind River Range is twice that on the SW. flank - about 49 and 26 tons per sq. mi. per year, respectively. Conversely, the stream runoff on the SW. flank is about 1 1/2 times that on the NE. This seeming anomaly is due principally to the erosive nature of a girdling band of pre-Tertiary rocks exposed on the NE. flank.

Five drainage basins are selected on the SW. side of the mountains and 6 on the NE. side as representative samples of the geologic terranes. The computed discharge-weighted concentrations of dissolved solids range from 25 to 34 p.p.m. on the SW. and from 37 to 276 p.p.m. on the NE.

Techniques used in the computations of chemical degradation rates include: adjustment of short-term flow-duration curves to a base 1914-1957 period, correlation of chemical concentrations with water discharges, calculation of solute yield from flow duration curves and discharge-concentration correlations, and correction of gross yields for soluble material in precipitation.--Auth.

3-3424. Farvolden, R.N. GROUNDWATER RESOURCES, PEMBINA AREA, ALBERTA: Research Council Alberta, Prelim. Rept. 61-4, 26 p., 7 illus., table, 1961.

Nearly 60% of the water utilized for secondary recovery operations in the Pembina oil field is obtained from the Paskapoo formation. The present annual withdrawal from this formation is about 6×10^8 gallons per year.

The apparent transmissibility of the Paskapoo formation is variable; however, in only a few isolated areas are well yields less than 5 g.p.m. At the present rate of withdrawal, it is estimated that the piezometric surface of the Paskapoo formation will be lowered less than 24 ft. over the entire area. In a few parts of the area of the local overdraft will be

considerably greater. Observation wells completed in the Paskapoo formation indicate that to date there has been no significant decline in the piezometric surface. The decline observed in a few very shallow observation wells is ascribed to changes in surface drainage rather than to withdrawal of water for pressure maintenance.

It is considered that the present rate of withdrawal, continued for the anticipated life of 40 years for the oil field, will not significantly decrease the amount of water available for agricultural development.--W. A. Meneley.

3-3425. Charron, J.E. GROUND-WATER RESOURCES OF PLUM COULEE AREA, MANITOBA: Canada, Geol. Survey, Paper 60-62, 81 p., 9 figs., 5 tables, Maps 29-1960 and 30-1960 (in pocket), scale 1:126,720, 1961, 8 refs.

The Plum Coulee area comprises 1,080 sq. mi. bounded by 97°21'W., 98°05'W., the International Boundary, and 49°31'N. Water is provided at present by 1) well, 2) cistern, 3) dugout, and 4) hauling. Statistics on these methods indicate that there is a lack of good water in the area.

Precambrian rocks of the area are chiefly granite. Overlying Precambrian rocks are shales, sandstones, and limestones of Ordovician, Silurian, and Devonian age. Jurassic and Cretaceous rocks are predominantly shales interbedded with layers of sandstone and limestone. The surficial deposits are mainly glacial and lacustrine.

All the water contained in the consolidated rocks occurs in the sandstones, limestones, and shales and is commonly under artesian pressure. This water is generally too salty for use. The best aquifers in the area are the glaciofluvial sands and gravels associated with the till. Several suggestions concerning the location of possible aquifers are listed by township and municipality. These would, however, provide only limited amounts of potable water. From a discussion of temperature, precipitation, and evaporation, it is concluded that little precipitation becomes ground water. Well records are given in some detail, but only 2 of the 19 wells chemically analyzed can be classified as good sources of water.--M. Stewart.

3-3426. Waller, Roger M. DATA ON WATER WELLS AND SPRINGS IN THE CHUGIAK AREA, ALASKA: U.S. Geol. Survey, Repts., Open-File Ser., 28 p., map, 3 tables, 1960, 11 refs.

The Chugiak area, in S.-central Alaska, is rapidly being settled, principally by people working in the Anchorage area. The area is a glaciated bench along the Chugach Mountain front on the S. shore of Knik Arm. The Glenn Highway traverses the portion covered by this report.

Preliminary inventories of wells in the area and brief geologic reconnaissance indicate that glacial processes have determined the principal occurrences of ground water. The well data show that most wells penetrate sand and gravel deposited by former glacial meltwater streams. In addition, many wells, particularly the numerous dug wells, obtain water from sandy zones in glacial till. The till is a boulder clay locally called "hardpan." These wells and those drilled into the underlying metamorphic and sedimentary bedrock usually obtain only small quantities of water. The thickest sequence of unconsolidated deposits reported in well logs is over 400 ft., whereas bedrock is exposed at the surface in numerous places.

Chemical analyses were made of several samples and show that the water from wells and springs is moderately hard to hard, but is suitable for general domestic use.--Auth.

3-3427. Ritchie, E. A., and others. LOWER SAN JOAQUIN VALLEY WATER QUALITY INVESTIGATION: California, Dept. Water Resources, Bull. no. 89, 189 p., 3 figs., 16 pls., 31 tables, Dec. 1960 (not seen at AGI).

Three distinct bodies of ground water underlie most of the northern portion of the San Joaquin Valley. From the surface downward these are: 1) a fresh-water free ground-water body which occurs in unconsolidated deposits of gravel, sand, silt, and clay of Quaternary age; 2) a fresh-water confined ground-water body which occurs in unconsolidated sediments beneath an extensive, relatively impermeable Corcoran clay member; and 3) an extensive body of connate water of poor quality which underlies the entire area at depths of 1,000 to 3,500 ft. Total ground-water storage capacity in the area is approximately 32,000,000 acre-ft. for the depth interval 10 to 200 ft.

Ground-water levels in the free ground-water body stand at shallow depths, varying from 5 to 50 ft. Ground water in this zone moves from the valley margins toward the central trough, except for a few isolated ground-water mounds. Ground-water levels in the confined water body stand at variable depths ranging from 40 ft. above sea level to 80 ft. below sea level. Ground water in this zone moves from the areas of recharge along the E. side of the valley into areas of heavy ground-water extractions along the W. side of the valley.

More than 1,300 chemical analyses of ground water in the area were utilized in evaluating general water quality conditions. In general, ground waters along the E. side of the San Joaquin Valley are excellent to good in mineral quality, with total dissolved solids less than 700 p.p.m., chlorides less than 175 p.p.m., and B less than 0.5 p.p.m. The valley trough and W. side areas contain ground waters ranging from good to injurious or unsatisfactory in quality. Total dissolved solids in local areas may exceed 2,000 p.p.m., chlorides may exceed 350 p.p.m., and B may exceed 2 p.p.m.--R. C. Richter.

3-3428. Klein, Howard and C. B. Sherwood. HYDROLOGIC CONDITIONS IN THE VICINITY OF LEVEE 30, NORTHERN DADE COUNTY, FLORIDA: Florida Geol. Survey, Rept. Inv. no. 24, Pt. 1, 24 p., 11 pls, 1961.

Thin layers of dense limestone of low permeability that occur near the top of the Biscayne aquifer in the vicinity of the N. end of Levee 30 in Dade County are of hydrologic importance because they retard the downward infiltration of ponded water in Conservation Area no. 3. This retarding effect frequently results in high head differentials across the levee. Tests made in a small area adjacent to Levee 30 indicate that the coefficient of transmissibility of the aquifer is 3,600,000 g. p. d. (gallons per day) per ft., and the coefficient of vertical permeability of the dense limestones is 13 g. p. d. per sq. ft. If ground-water flow beneath the levee is laminar, the total inflow to the Levee 30 Canal from Conservation Area no. 3 will be about 350 m. g. d. (million gallons per day), or 540 c. f. s. (cubic feet per second), per mi. length of levee when the head difference across the levee is 10 ft.--Auth.

3-3429. Pride, R. W., and others. INTERIM REPORT ON THE HYDROLOGIC FEATURES OF THE GREEN SWAMP AREA IN CENTRAL FLORIDA: Florida, Geol. Survey, Inf. Circ. no. 26, 96 p., 22 figs., 3 tables, 1961, 17 refs.

The Green Swamp area as used in this report is located near the center of the Florida Peninsula. It covers an area of almost 900 sq. mi. of swampy flatlands and sandy ridges. The elevation of the land surface varies from about 200 ft. above mean sea level in the eastern part to about 75 ft. in the river valleys in the western part of the area.

About 720 sq. mi. of the Green Swamp area is drained by the Withlacoochee River. Streams that drain into the St. Johns River, Hillsborough River, Kissimmee River, and Peace River basins also originate in or near the area. The drainage divides of these basins are broken in several places by swamp channels and gaps in the surrounding ridges. Water may flow through these gaps from one basin to another, the direction often not definitely established but depending on the relative elevation of the water level in each basin. These interconnections have a significant influence on the surface drainage pattern of the area.

During the water year ending Sept. 30, 1959, the rainfall over the Green Swamp area was about 72.5 in., 20 in. above normal. The runoff from the area during this period was 24.26 in. Drainage operations in recent years have not significantly changed the amount of annual runoff from the total area. However, the distribution of the drainage has been changed by canals that divert some of the flow from the upper Palatka Creek into the Withlacoochee River.

The Floridan aquifer underlies all of the Green Swamp area. It is composed of porous marine limestones. The aquifer crops out in the western part of the area and occurs at depths of more than 200 ft. below land surface in the eastern part. The Floridan aquifer is overlain by a nonartesian aquifer which consists primarily of sand and clay. The nonartesian aquifer is thin or absent in the western part of the area and ranges from 50 to 100 ft. in thickness in the eastern part. The principal source of recharge of ground water in the nonartesian aquifer is local rainfall.

Piezometric levels in the Floridan aquifer occur at an elevation of about 130 ft. above mean sea level in the southeastern part of the area. Recharge to the Floridan aquifer occurs along the eastern side of the area.

The maximum mineral content found in the surface water was 122 parts per million and the maximum in ground water was 350 p. p. m. Generally water is considered to be usable if the mineral content is less than 400 to 500 p. p. m. Surface water was highly colored but ground water was relatively clear.--Auth.

3-3430. Wyrick, Granville G. RECORD OF WELLS IN VOLUSIA COUNTY, FLORIDA: Florida, Geol. Survey, Inf. Circ. no. 24, 96 p., 2 figs., pl., table, 1961.

Detailed studies of geology and ground-water resources of Volusia County were published earlier by the Florida Geological Survey (Information Circular No. 8 and Report of Investigations No. 22). The current report presents supporting data of well records that were compiled during this investigation.--H. S. Puri.

3-3431. Fowler, K. H. PRELIMINARY REPORT ON GROUND WATER IN THE SALMON FALLS

AREA, TWIN FALLS COUNTY, IDAHO: U.S. Geol. Survey, Circ. 436, 17 p., 4 figs., pl., 1960, pub. 1961.

The area contains about 85,000 acres of irrigable land, of which about 30,000 acres receives a partial supply from surface water. A few irrigation wells supplement the supply, and a moderate additional amount of ground water probably can be developed from the basalt and interbedded sedimentary rocks. --U.S. Geol. Survey.

3-3432. Rodis, Harry G. AVAILABILITY OF GROUND WATER IN LYON COUNTY, MINNESOTA: U.S. Geol. Survey, Circ. 444, 7 p., fig., 1961.

Ground water in Lyon County is available principally from sand and gravel in glacial drift and from sandstone of Cretaceous age. The county has been divided into areas of ground-water availability based on the quantity and quality of water available from these units. The geographic and stratigraphic distribution of the geologic units suggests that additional water supplies may be available from strata not yet fully explored.--U.S. Geol. Survey.

3-3433. Cotter, R.D., and J.E. Rogers. EXPLORATORY DRILLING FOR GROUND WATER IN THE MOUNTAIN IRON-VIRGINIA AREA, ST. LOUIS COUNTY, MINNESOTA: U.S. Geol. Survey, Water-Supply Paper 1539-A, 13 p., 2 figs., 2 pls. (in pocket) incl. geol. map, scale 1:24,000, 2 tables, 1961, 5 refs.

The Mountain Iron-Virginia area is a broad, SW.-trending valley in the central part of the Mesabi Range. The valley, which heads in the Laurentian Divide and covers about 120 sq. mi., coincides approximately with a bedrock valley filled with as much as 150 ft. of glacial deposits.

A complex sequence of glacioaqueous sediments made up of clay, silt, sand, and gravel was delineated from test holes drilled at 238 sites. These sediments range in thickness from 0 to 125 ft. and can be considered a hydrologic unit, bounded below by sandy till or bedrock and above by as much as 60 ft. of clayey till. The piezometric surface ranges from 0 to about 70 ft. below land surface; thus, the glacioaqueous deposits are not everywhere completely saturated. In places, however, the water is under artesian pressure.

Within the Mountain Iron-Virginia area about 50 sq. mi. are underlain by deposits 20 ft. or more in thickness of silt, sand, or gravel that constitute an aquifer that is a large potential source for additional water supplies. Except for Fe and Mn, which are present in excessive amounts in some wells, the water meets U.S. Public Health Service standards for municipal supplies. Pumping tests of wells in the permeable sand or gravel deposits at 5 sites indicate that yields of several hundred gallons per minute and possibly as much as 2,000 g.p.m. can be expected.--Auth.

3-3434. Schneider, Robert. CORRELATION OF GROUND-WATER LEVELS AND AIR TEMPERATURES IN THE WINTER AND SPRING IN MINNESOTA: U.S. Geol. Survey, Water-Supply Paper 1539-D, 14 p., 6 figs., 1961, 13 refs.

In a study of natural ground-water recharge in Minnesota a close relationship was observed between air temperatures and ground-water levels in the winter and spring. Hydrographs of 2 wells, one in the

S.-central part of the state, the other in the NE., indicate that the water table declines during the winter when the mean daily air temperature remains below 32°F. Within a few days after the air temperature has risen above freezing, ground-water recharge begins. If below-freezing temperatures return for some time, the water table again declines.

It has been shown in the laboratory that capillary water and water vapor move in the direction of the thermal gradient. The winter decline of the water table probably is caused in part by the upward movement of moisture below the frozen soil by capillarity, resulting in accretion to the frost layer from below. When the air temperature rises above freezing, the water table begins to rise as a result of downward percolation of melt water from the bottom of the frost layer.

The largest increment of ground-water recharge in Minnesota occurs in the spring. Because of the comparatively great depth of frost penetration and the relative impermeability of frost, the initial source of spring recharge is largely frostmelt. The frozen soil impedes or prevents the downward movement of snowmelt and rain. Once the frost layer is dissipated, recharge from infiltrating surface water begins. In addition, the reversal of the temperature gradient results in the downward movement of moisture from the warming soil zone to the water table.--Auth.

3-3435. West, Sam W. AVAILABILITY OF GROUND WATER IN THE GALLUP AREA, NEW MEXICO: U.S. Geol. Survey, Circ. 443, 21 p., 2 figs., pl., 1961.

The problem of providing an adequate supply of water for Gallup and vicinity is reviewed. The physical and hydrologic properties of the principal aquifers in the area and the chemical quality of the water in them are described briefly. The yields and specific capacities of wells that tap each aquifer are summarized. In addition to well water, a supply from the San Juan River may become available.--U.S. Geol. Survey.

3-3436. Price, Don. RECORDS OF WELLS, WATER LEVELS AND CHEMICAL QUALITY OF GROUND WATER IN THE FRENCH PRAIRIE-MISSION BOTTOM AREA, NORTHERN WILLAMETTE VALLEY, OREGON: Oregon, State Engineer, Ground Water Rept. no. 1, 314 p., 3 figs. incl. map (in pocket), scale 1 in. to approx. 3/4 mi., 3 tables, March 1961, 2 refs.

An investigation of the ground-water resources of the northern Willamette Valley was begun in 1960 as a cooperative program between the Ground Water Branch, U.S. Geological Survey, and the Oregon State Engineer.

The northern Willamette Valley area is one of the fastest growing areas of ground-water use within the state. The purpose of the investigation is to obtain an understanding of the availability, movement, and chemical quality of the ground-water resources of the area. This information is needed to attain an optimum development of the ground-water resources of the area and to aid in the prevention of problems of overdevelopment and pollution.

The first phase of the program was the collection of well records, water level records, and chemical quality data in the central part of this area, which is known as the French Prairie-Mission Bottom area. The records collected in this phase of the study are essential in the preparation of an interpretive report

describing the occurrence and movement of ground water in the French Prairie-Mission Bottom area. These records, which will not be included in the interpretive report that is being prepared at this time, are being made available in this publication to aid in the location and the development of the ground-water resources of the area, and to serve as a supplement to the forthcoming interpretive report.--Foreword.

3-3437. West Texas Geological Society, Ground Water Committee. **SHALLOW FORMATIONS AND AQUIFERS OF THE WEST TEXAS AREA:** 16 secs., West Texas Geological Society, P.O. Box 1595, Midland, Texas, 1961 (not seen at AGI).

This joint publication of the West Texas Geological Society and the Permian Basin Geophysical Society consists of a set of 16 cross-sections, covering much of the Permian basin of W. Texas. These sections show the correlations of all shallow formations from the surface down to the Permian Yates sand and, in some cases, even deeper. Based principally on radioactivity and electrical logs.--West Texas Geol. Soc.

3-3438. Morris, Donald A., and Horace M. Babcock. **GEOLOGY AND GROUND-WATER RESOURCES OF PLATTE COUNTY, WYOMING.** With a Section on Chemical Quality of the Water by Russell H. Langford: U.S. Geol. Survey, Water-Supply Paper 1490, 195 p., 20 figs., 4 maps (in pocket) incl. 2 col. geol. maps, 11 tables, 1960, 45 refs.

Platte County has an area of 2,114 sq. mi.; it lies within parts of 2 major physiographic provinces, the northern extension of the Southern Rocky Mountain and the northwestern part of the Great Plains. The Laramie Range and related structures lie along the western margin of the county and constitute the eastern limit of the Rocky Mountain Front Range. The High Plains section of the Great Plains province extends eastward from the Laramie Range over the remainder of the county. The original surface of the High Plains has been deeply eroded, and in the northeastern part of the county it is broken by the broad uplifted structural platform of the Hartville Hills. The North Platte River and its tributaries have entrenched their channels as much as 1,000 ft. into the plains, leaving wide, very flat intervalley areas that are interrupted by a few isolated buttes and outlying ridges. Well-defined terraces, locally called the Wheatland Flats, have been formed in central Platte County. The climate is semiarid, the average annual precipitation being about 15 in. Farming and stockraising are the principal occupations in the county.

Most of the rocks exposed in the county are of Tertiary and Quaternary age, although rocks as old as Precambrian crop out locally. The Arikaree and Brule formations and younger deposits, including Tertiary(?) deposits (undifferentiated) and terrace, floodplain, and other alluvial deposits, underlie more than two-thirds of the county. Mesozoic, Paleozoic, and Precambrian rocks crop out in the other third and underlie the younger rocks at great depths elsewhere.

Small supplies of ground water adequate for domestic and stock use can be obtained from shallow wells in the Casper, Hartville, Cloverly, Brule, and Arikaree formations and in the terrace and flood-plain deposits. Small to moderate amounts of ground water can be obtained from the "Converse sand" of the Hartville formation. Several flowing wells obtain water from this sand near Glendo. Moderate to large sup-

plies of ground water adequate for small-scale irrigation or industrial uses or for public supply can be obtained from properly constructed wells penetrating thick saturated sections of the Arikaree formation and from the terrace and flood-plain deposits. Large supplies of ground water can be obtained from the flood-plain deposits of the North Platte River near Guernsey, where wells commonly yield more than 1,000 g.p.m. (gallons per minute). The aquifers with greatest potential for additional ground-water development in Platte County, in decreasing order of importance, are the flood-plain deposits along the North Platte River and its tributaries, the Arikaree formation and terrace deposits in parts of the Wheatland Flats, and the "Converse sand" in the general vicinity of Glendo.

The depth to the water table ranges from less than 5 ft. in the Wheatland Flats area to more than 250 ft. in the E.-central part of the county. The water in the Tertiary and Quaternary rocks moves generally eastward across the county.

The ground-water reservoir in Platte County is recharged by precipitation that falls within the area, by seepage from streams entering the area from the N., W., and S., and by seepage from irrigation. Most of the ground-water recharge to the terrace deposits underlying the Wheatland Flats area is derived from irrigation seepage. Owing to the lack of surface irrigation water in the dry years preceding and during this study, the water table has declined and the yields of irrigation wells have decreased. Ground water is discharged from the ground-water reservoir by seepage into perennial streams, by evapo-transpiration in areas of shallow water table, by underflow into adjacent areas to the E., by flow to springs, and by pumping from wells.

Most wells in the county were drilled but a few were dug. Of the 491 wells listed in this report, 334 were domestic and stock wells, 75 were irrigation wells, 6 were industrial wells, and 16 were public-supply wells; the remainder were unused. Water from many springs in the county is used for stock and domestic water supplies.

Ground water in Platte County generally is moderately mineralized, containing about 200 to 800 p.p.m. (parts per million) of dissolved solids, hard, and of the calcium bicarbonate or calcium sulfate type. The chemical composition of water from terrace deposits underlying irrigated lands resembles that of the applied surface irrigation water; calcium and magnesium bicarbonates and sulfates are the major dissolved salts. Concentrations of dissolved salts are somewhat higher in the ground water from the terrace deposits than in the applied surface irrigation water; the concentration increases with increased distance of ground-water movement away from the irrigated area. Water from flood-plain deposits in Horseshoe, Bear, and Cottonwood Creek valleys and from the Arikaree, Brule, Cloverly, and Hartville formations generally is of the calcium bicarbonate type but locally contains sulfate in excess of bicarbonate.

The ground water is of excellent quality for irrigation except for its medium to high salinity. The concentration of B is less than 0.5 p.p.m., and the maximum Na-adsorption ratio is 2.4. Because of its salinity, the water should be used for irrigation only on soils having a good subsurface drainage and for plants having a moderate to high salt tolerance, such as grains, sugar beets, and alfalfa. The water is suitable for domestic and some industrial uses except locally where its Fe content is high. Because the water is generally very hard, it would require treatment before it could be used for many industrial purposes.--Auth.

3-3439. Berry, Delmar W., and Robert T. Littleton. **GEOLOGY AND GROUND-WATER RESOURCES OF THE OWL CREEK AREA, HOT SPRINGS COUNTY, WYOMING:** U.S. Geol. Survey, Water-Supply Paper 1519, 58 p., 9 figs., 2 maps. (in pocket) incl. col. geol. map, scale 1:63,360, 6 tables, 1961, 18 refs.

About 250 sq. mi. is included in the project area, which consists of relatively broad valleys and flat terraces grading into rugged folded and faulted uplands. The project area lies at the southern end of the Big-horn structural basin. The climate is semiarid; the normal annual precipitation is about 13 in.

The exposed rocks range in age from Pennsylvanian to Recent; the younger deposits are exposed in and along the valleys, the older deposits in the uplands adjacent to the valleys. The alluvium and terrace deposits yield water to domestic and stock wells throughout the area and locally yield moderate to large quantities of water for irrigation. Large quantities of ground water can be obtained for only a short time, however, because recharge is not sufficient to sustain large yields for long periods. Some of the older formations that underlie the area (Madison limestone and Tensleep sandstone) yield large supplies of water to artesian springs. Other formations (the Cloverly and the Frontier formations and the Cody shale) can yield water under artesian pressure to domestic and stock wells.

The depth to the water table ranges from only a few feet in the river flood plain to about 70 ft. at the margins of the valleys. The water in the terrace and alluvial deposits moves generally eastward toward the Big-horn River.

The ground-water reservoir is recharged princi-

pally by precipitation that falls either on the area or on adjacent areas and by percolation from irrigation water and streams. Ground water is discharged principally by evaporation and transpiration, by seepage into streams, and through springs and wells.

Most of the wells in the Owl Creek area were drilled, but some were dug and a few were bored or driven. Only 8 wells in the area are used for irrigation. The yield of the irrigation wells ranges from about 50 to 500 g.p.m. Ground water for irrigation can be developed most practicably from the alluvium in the part of the valley that extends from the W. side of Rose Dome to the vicinity of sec. 10, T. 43., R. 99 W., and from the terrace deposits N. of Owl Creek in the central part of the area. The total amount of water that can be pumped from these aquifers is relatively small and depends on the amount of seepage from irrigation water applied to the land.

The relatively few data obtained during this investigation indicate that ground water from the principal aquifers in the Owl Creek area - the Chugwater and Frontier formations, the Cody shale, and the unconsolidated deposits - is of poor chemical quality; all the ground water is highly mineralized, and that from the unconsolidated deposits is very hard. The water is unsuitable for irrigation and is objectionable for domestic use because of large amounts of dissolved solids (more than 2,000 p.p.m.), mostly sodium sulfate. However, some water from unconsolidated deposits might be classified as safe for supplemental irrigation if applied under carefully controlled conditions. Conversely, the surface water, especially in the upstream part of the area, is of generally good quality for irrigation, although at some times and in some places it is unsuitable.--Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 3-3187, 3-3191, 3-3193; Geomorphology 3-3227; Stratigraphy 3-3263; Geophysics 3-3320; Mineralogy 3-3365, 3-3366.

3-3440. Weber, F. Harold, Jr. **MINERAL RIGHTS:** California, Div. Mines, Mineral Inf. Service, v. 14, no. 2, p. 1-15, 3 figs., 3 tables, Feb. 1961, 19 refs.

Because of the complex pattern of land ownership and administration that exists today, procedures for acquiring land rights to prospect, to mine, and to explore for petroleum can involve substantial problems. Status and ownership of land should be determined fully before a mineral exploration program is undertaken.

A table is provided that briefly outlines the procedures for acquiring mineral rights to various types of government and private lands in California. Also included are brief summaries of the ordinances of individual counties that affect mineral development. The article concludes with a brief historical review of the development of mining law and land ownership and legislation, as it has affected mineral development in the state.--Auth.

3-3441. Baker, Arthur, 3d, and Bill C. Scott. **THE MINE GEOLOGIST - PAST PROBLEMS, PRESENT PURPOSE AT PITCH:** Mining Engineering, v. 13, no. 5, p. 488-491, illus., 3 figs., May 1961.

The authors depict the role of the mining geologist in the early days of the Pitch [U] mine [Marshall Pass district, Colorado] and of their present use in the operation of the mine.--Auth.

3-3442. Chenoweth, William L., and Page P. Blakemore. **THE RIVERVIEW MINE, COCONINO COUNTY, ARIZONA:** Plateau, v. 33, no. 4, p. 112-114, map, Apr. 1961, 3 refs.

Metatorbernite is the only U mineral in the River-view mine. The unusual deposit is a collapsed pipe structure on the Black Point segment of the E. Kaibab monocline. More Cu occurs here than in any other U deposit in the Cameron area.--M. Russell.

3-3443. Schlottmann, Jerome D. **FOOTHILLS MINE, IDLEDALE DISTRICT, JEFFERSON COUNTY, COLORADO:** U.S. Atomic Energy Comm., [Pub.] RME-138, 7 p., plan, sec., table, March 1961.

The Idledeale district includes 2 U mines (Foothills and Grapevine) and several U prospects in an area of slightly less than 1 sq. mi. Rock outcrops in the central part of the district are visibly altered and stained with limonite. The U occurrences lie on the outer limits of the altered area.

The area is underlain by the Precambrian Idaho Springs formation which locally consists largely of quartz biotite foliates with some amphibolite beds. Chonolithic masses of quartz monzonite, apparently products of granitization, crop out in and adjacent to the district.

The Foothills vein, occupying a fissure fault, forms an arcuate trace for 2,000 ft. across the SW. quadrant of the Idledeale district. The strike ranges from N. 20°W. in the W. part of the district to

N. 60°W. in the S. part. The dip is easterly, ranging from 50° to 80°.

The vein cuts the quartz monzonite, the quartz biotite foliates, and the silica-cemented quartz monzonite breccia. Commercial ore occurs where this competent breccia forms the hanging wall. The vein deflects to the right, and ore grade increases at or shortly beyond contacts where it enters areas where quartz monzonite breccia forms both the hanging wall and footwall.

Dilated zones along the vein have been filled with late rhythmic bands of calcite and pyrite. Where these dilated zones are still open, to widths as great as 2 or 3 ft., the surfaces are coated by drusy calcite and pyrite, and by coffinite and sooty uraninite.

Ore and metallic vein minerals found in the vein are pitchblende, coffinite, chalcopyrite, galena, sphalerite, marcasite, limonite, and pyrite. Non-metallic gangue minerals are potash feldspar, carbonate, quartz, chlorite, and fluorite.

Vein filling was accomplished in 2 stages. The first stage consisted of filling of the fracture by granular-textured microcrystalline carbonate, pitchblende, and potash feldspar. The second stage of vein development is manifested by brecciation of minerals of the first stage and by cementation of the breccia by fluorite, coarse crystalline carbonate, and sulfides. During this stage, potash feldspar and pitchblende were partly replaced by carbonate. Subsequent oxidation of the upper part of the vein resulted in deposition of mixtures of coffinite and sooty uraninite thought to be of secondary or supergene origin immediately below the zone of oxidation. --From auth., p. 3, 5.

3-3444. Dunham, Robert J. GEOLOGY OF URANIUM IN THE CHADRON AREA, NEBRASKA AND SOUTH DAKOTA: U.S. Geol. Survey, Repts., Open-File Ser. no. 608, 243 p., 36 figs., geol. map (in pocket), scale 1:48,000, 9 tables, 1961, 117 refs.

The Chadron area covers 375 sq. mi. about 25 mi. SE. of the Black Hills. Recurrent mild tectonic activity and erosion on the Chadron arch, a compound anticlinal uplift of regional extent, exposed 1,900 ft. of Upper Cretaceous rocks, mostly marine shale containing pyrite and organic matter, and 600 ft. of Oligocene and Miocene rocks, mostly terrestrial fine-grained sediment containing volcanic ash. Each Cretaceous formation truncated by the sub-Oligocene unconformity is stained yellow and red, leached, kaolinized, and otherwise altered to depths as great as 55 ft. The composition and profile of the altered material indicate lateritic soil; indirect evidence indicates Eocene(?) age. In a belt through the central part of the area, the Brule formation of Oligocene age is a sequence of bedded gypsum, clay, dolomite, and limestone more than 300 ft. thick.

U in Cretaceous shale in 58 samples averages 0.002%, 10 times the average for the earth's crust. Association with pyrite and organic matter indicates low valency. The U probably is syngenetic or nearly so.

U in Eocene(?) soil in 43 samples averages 0.54%, ranging up to 1.12%. The upper part of the soil is depleted in U; enriched masses in the basal part of the soil consist of remnants of bedrock shale and are restricted to the highest reaches of the ancient oxidation-reduction interface. The U is probably in the form of a low-valent mineral, perhaps uraninite. Modern weathering of Cretaceous shale is capable of releasing as much as 0.780 p.p.m. U to water. Eocene(?) weathering probably caused enrichment of the ancient soil through 1) leaching of Cretaceous shale, 2) downward migra-

tion of uranyl complex ions, and 3) reduction by hydrogen sulfide at the water table.

U minerals occur in the basal 25 ft. of the gypsum facies of the Brule formation at the 2 localities where the gypsum is carbonaceous; 16 samples average 0.066% U and range up to 0.43%. Elsewhere U in dolomite and limestone in the basal 25 ft. of the gypsum facies in 10 samples averages 0.007%, ranging up to 0.012%. Localization of the U at the base of the gypsum facies suggests downward moving waters; indirect evidence that the water from which the gypsum was deposited was highly alkaline suggests that the U was leached from volcanic ash in Oligocene time. --Auth.

3-3445. Young, E.J., and Paul K. Sims. PETROGRAPHY AND ORIGIN OF XENOTIME AND MONAZITE CONCENTRATIONS, CENTRAL CITY DISTRICT, COLORADO: U.S. Geol. Survey, Bull. 1032-F, p. 273-299, 8 figs., 7 tables, 1961, 23 refs.

Xenotime and monazite are uncommonly abundant in Precambrian biotite gneiss and migmatite at 3 localities near Central City, Gilpin County. The occurrences are in the lower part of a thick layer of migmatized biotite gneiss in a sequence of rocks that have been metamorphosed to the almandine amphibolite facies. The zones of concentration are a maximum of about 5 ft. thick and a few hundred feet long, and contain about 1 to 5% by volume combined xenotime and monazite.

The rare-earth minerals occur dominantly as aggregates of sand-size crystals in thin layers and clots of biotite, which are much coarser than the mica in the typical biotite gneiss. Xenotime is more abundant than monazite in 2 of the 3 occurrences. Both minerals are subrounded to rounded, and crystal faces are rare. The 2 minerals appear to have crystallized contemporaneously. Except for magnetite, other accessory minerals that are common to the country rock are not concentrated with the xenotime and monazite.

The field and laboratory data are consistent with the hypothesis that the rare-earth minerals were concentrated at their present sites during migmatization of the biotite gneiss country rock, in a period of Precambrian plastic deformation. Presumably, granitic fluids derived during the deformation selectively mobilized rare-earth cations and phosphate from the biotite gneiss country rock. These ions crystallized with biotite and locally with magnetite to form zones of xenotime and monazite concentrations in migmatized parts of the gneiss. --Auth.

3-3446. SOUTHERN CALIFORNIA SOURCE FOR SILICA AND FELDSPAR: Ceramic News, v. 9, no. 12, p. 12, illus., 1960.

Deposits and processing operations of the Campo Milling Co., Ltd., 60 mi. E. of San Diego, are described. The silica deposit is plus 99% SiO₂, and the feldspar is a potash type with a trace of Fe. --D. J. Barbour (courtesy Ceramic Abstracts, June 1961, p. 149).

3-3447. Govett, G.J.S. OCCURRENCE AND STRATIGRAPHY OF SOME GYPSUM AND ANHYDRITE DEPOSITS IN ALBERTA: Research Council Alberta, Bull. 7, 62 p., 21 diag. (2 in pocket), 14 tables, 1961.

Triassic gypsum deposits are present at Mowitch and Fetherstonhaugh creeks in the Rocky Mountains

N. of Jasper; both these deposits are tentatively correlated with the subsurface Upper Triassic evaporitic Charlie Lake formation of the Peace River area.

Middle Devonian deposits occur at Peace Point, along the Salt, Slave, and Little Buffalo rivers, and subsurface at McMurray. The lower gypsum bed along the Salt, Slave, and Little Buffalo rivers is correlated with the Chinchaga formation of northwestern Alberta, the second, third, and fourth salt beds in central Alberta, and the Meadow Lake formation of Saskatchewan. The McMurray deposit is correlated with the Pine Point and Presqu'île formations in the Northwest Territories, the upper gypsum bed along the Little Buffalo River, the Muskeg formation of northwestern Alberta, possibly the lower part of the Peace Point deposit, the first salt of central Alberta, and the Prairie evaporite of Saskatchewan. At least the upper part of the Peace Point deposit is correlated with the Fort Vermilion member of the Slave Point formation, and is possibly equivalent to the upper part of the McMurray deposit. A small gypsum deposit of Upper Devonian age occurs at Head Creek in the Highwood Range of southern Alberta.

The possibility of economic development is discussed from the point of view of markets, utilization, location, transportation facilities, quality, reserves, and possible extensions of the deposits.

The possibilities of the presence of K salts in Middle Devonian strata in Alberta and the age and nomenclature of Devonian evaporitic deposits are discussed in appendices.--Auth.

3-3448. Cleveland, George B. **GEOLOGY OF THE OTAY BENTONITE DEPOSIT, SAN DIEGO COUNTY, CALIFORNIA:** California, Div. Mines, Spec. Rept. 64, 16 p., 6 illus., map (in pocket), scale 1 in. to 1,000 ft., 5 figs., 3 tables, 1960, 31 refs.

Bentonite occurs locally in Pliocene sedimentary rocks in the coastal region of the southwestern San Diego County. The lower Otay Valley contains a high-grade deposit of bentonite from which as much as 83,000 tons of clay, valued at about \$670,000, has been obtained from the 2 principal mines, the General Petroleum Company mine, and the Standard Oil Company mine. The bentonite is intercalated in the flat-lying sandstone and arkose beds of the middle or late Pliocene San Diego formation. In the Otay area this formation and the overlying Plio-Pleistocene Sweitzer formation have a combined thickness of about 320 ft. In late Cenozoic time marine wave-cut terraces were formed on these and older rocks in the San Diego region. In the Otay area the Otay, Sub-Otay, and Avondale terraces are most prominent.

Bentonite occurs in 6 or more beds which range in thickness from less than 1 ft. to 4 ft. or more. The high-grade clay underlies an area of 1.3 sq. mi. and contains reserves of more than 8.5 million tons of clay. Outside the mapped area bentonitic sandstone was found at 25 additional localities. Because of its high base exchange capacity the Otay bentonite has been used almost entirely as a decolorizer in refining petroleum products. The bentonite was derived from the alteration of a volcanic ash which may be related to the basic extrusive and pyroclastic rocks of the Salada formation in northwestern Baja California Norte, Mexico.--Auth.

3-3449. **CALIFORNIA BALL CLAYS BEING SHIPPED TO MAJOR SANITARY-WARE PLANTS:** Ceramic News, v. 10, no. 1, p. 11-12, 4 illus., 1961.

Deposits and chemical analyses are given for 7

Oakdale clays including ball and fire clays and white-firing kaolins. The deposits are in the western foothills of the Sierra range in Stanislaus and Toulumne counties.--D. J. Barbour (courtesy Ceramic Abstracts, June 1961, p. 149).

3-3450. Robinson, G. C., and others. **COMMON CLAYS OF THE COASTAL PLAIN OF SOUTH CAROLINA AND THEIR USE IN STRUCTURAL CLAY PRODUCTS:** South Carolina, State Devel. Board, Div. Geology, Bull. no. 25, 71 p., 10 figs., fold. map, 7 tables, 1961, 5 refs.

Annual production of the American structural clay products industry is currently valued at about \$375,000,000. Rapid technological advances are being made in this industry, and increasingly stringent requirements are being placed on the raw materials used.

Clay resources of South Carolina coastal plain include kaolin clays, siliceous shale or "fullers earth," bentonite, and common clays. Commercial kaolin deposits occur in the Tuscaloosa formation of Upper Cretaceous age in the northwestern part of the coastal plain. Siliceous shale, or "fullers earth" as it has been called, is present in beds of Eocene age in Aiken, Lexington, Calhoun, Sumter, Williamsburg, and Georgetown counties. Nonswelling bentonite occurs over hundreds and possibly thousands of acres in Jasper County. Common brick clays are present at a great many places throughout the coastal plain.

Laboratory investigation of 42 samples of clays indicate that resources of common clays suitable for use in structural clay products are abundant in the coastal plain of South Carolina. Some clays are well suited for almost the whole range of structural clay products. Others would require selective mining and blending of materials to overcome defects.

Investigations of the effect of the sand content of a clay on its ceramic properties indicate that a greater amount of sand in the minus 48 plus 100 mesh size range can be tolerated than can coarser or finer sand. Removal of sand by washing greatly increases the dry and fired strengths of clays and commonly results in a lower maturing temperature, reduced absorption, and smoother surfaces after firing.--Auth.

3-3451. Hosterman, John W., and others. **INVESTIGATIONS OF SOME CLAY DEPOSITS IN WASHINGTON AND IDAHO:** U.S. Geol. Survey, Bull. 1091, 147 p., 11 maps (8 geol. maps in pocket), sec., graph, 4 tables, 1960, 30 refs.

The investigation of clay resources, made jointly with the U.S. Bureau of Mines 1942-1947, began as a part of a general investigation of possible sources of Al in the United States. It was undertaken as a precaution against the depletion of Al reserves, owing to the greatly increasing demand for Al during World War II.

The clay deposits of eastern Washington and northern Idaho, known as the Palouse hills, are at the eastern edge of the Columbia Plateau physiographic province. Three types of clay occur in the area: residual clay derived from the Columbia River basalt of Tertiary age; residual clay derived from the granodiorite and related intrusive rocks of the Idaho batholith of Late Jurassic or Cretaceous age; and transported clay, an erosional product of the granodiorite and related intrusive rocks, deposited as part of the Latah formation of Tertiary age. The 2 types of residual clay were formed during an interval of weathering called the "Excelsior weathering period"

that occurred between flows of the Columbia River basalt, when the land surface had a low to moderate relief and the climate was warm and humid with good oxidation conditions.

The mineral composition of a few samples have been studied in detail. X-ray and differential thermal determinations on these clays show that kaolinite and halloysite (hydrated) are the principal clay minerals. The residual clay derived from basalt is composed of white halloysite commonly colored blue, gray, or black by ilmenite and occasionally stained brown by limonite or green from nontronite. The residual clay derived from granodiorite and related intrusive rocks contains both halloysite and kaolinite, and the transported clay is predominantly kaolinitic. The latter 2 types of clay are very similar in physical appearance; both are white and both contain abundant quartz grains and mica flakes - but the residual clay retains a relict granitic texture and is not bedded.

It is estimated that about 300,000 tons (dry) of clay containing more than 20% available alumina occurs in eastern Washington and northern Idaho. About 90% of this tonnage is in 4 major deposits in Latah County, Idaho: Bovill clay deposit, Olson high-alumina clay deposit, Canfield-Rogers clay deposits, and Benson clay deposit.--Auth.

3-3452. Reves, William D. THE LIMESTONE RESOURCES OF WASHINGTON, HOLMES AND JACKSON COUNTIES, FLORIDA: Florida, Geol. Survey, Bull. 43, 121 p., 27 figs., 9 tables, 1961.

The tri-county area of Washington, Holmes, and Jackson counties is located in the central part of the Florida panhandle and consists of a total land surface area of 2,073 sq. mi. Limestones of upper Eocene (Ocala group), Oligocene (Marianna limestone, Byram formation, and Suwannee limestone) and Miocene (formations of the Tampa, Alum Bluff, and Choctawhatchee stages) ages are either exposed in this tri-county area or are available at depth by using present mining techniques. This study points out the unused natural resources in economically minable quantities which could be utilized for many limestone products. Channel samples were collected from chosen localities, both known and new (sinks, quarries, surface outcrops, and river sections), because of accessibility to mining, size of the deposit, and for general lithologic information. Insoluble residues, chemical analyses, soil tests (liquid limit, plastic limit, plastic index, shrinkage limit, and Los Angeles abrasion) were determined in the laboratory for each sample. These data are recorded in 4 tables. In Washington County (area 624 sq. mi.), 5 areas of potential economic importance are described in detail. Over 23 million cu. yds. of high-grade limestone are available in these areas. In Holmes County (area 506 sq. mi.), over 1.5 million cu. yds. of high-grade minable limestone are available. Jackson County (area 942 sq. mi.) has an abundance of limestone resources, and millions of tons of such occur in 8 areas. Each area is delineated on topographic maps and is described in detail with regard to its economic potential.

Limestone as an economic deposit is discussed, and functions and uses of limestone are presented. Current mining (open pit) and wet mining methods are discussed in the report. A section on availability of transportation gives information on highways, rail, air, and waterways. Highways of the Florida panhandle, rail shipping costs per ton for limestone and crushed stone, and route of the proposed natural gas pipeline through W. Florida are illustrated on maps.--H.S. Puri.

3-3453. Quebec, Dept. of Mines. THE MINING INDUSTRY IN THE PROVINCE OF QUEBEC IN 1959: 165 p., 4 pls., 65 tables, 1961.

In 1959, the value of the mineral production of the Province of Quebec reached the sum of \$441,299,661, the highest of its recorded history. Between 1945 and 1959, the value of the metallic substances produced in Quebec has increased fivefold.

During this period, the mining industry of the province has been growing constantly, even though the value of its production dipped down in 1953, 1957, and 1958. Although similar fluctuations may occur again, the scope of exploration, development, and pre-production works undertaken or carried on during 1959 indicate that the value of this mineral production might exceed the half-billion dollar mark in the not too distant future.

Of the 30 substances or products listed in the table of the mineral production of the province, 19 recorded increases in 1959. Cu, Fe ore, asbestos, titanium oxide, and building limestone are the substances that have gained the most in value.

Compared with the values obtained in 1958, this increase in the value of the mineral substances is 31% for the metallics, 15% for the industrial minerals, and 5% for the building materials. As a whole, the sum of \$441,299,661 received by the Quebec producers for the year under review is 20% greater than the cumulative total of \$366,001,902 registered in 1958.--From p. 1.

The report deals in turn with metallic substances; nonmetallic minerals; exploration; development and mining operations; and employment, wages, and accidents in mines and quarries in 1959.

3-3454. Quebec, Dept. of Mines. OUTLINE OF PROGRESS OF THE MINING INDUSTRY IN THE PROVINCE OF QUEBEC DURING THE YEAR 1960: 29 p., illus., 1961.

Preliminary statistics, prepared by the Dept. of Mines at the end of Dec. 1960, set the value of the mineral production of the province at \$441,375,965. This figure is only \$76,304 higher than that of 1959.

The decline in industrial activity in the United States had its repercussions on certain sections of the mining industry of Quebec. Fe ore producers were the most affected by it, and their sales decreased 33%. On the other hand, the production of metallic Fe increased by 52%.

The stability of the price of Cu, which hovered around 30¢ per lb. through most of the year, and the sustained demand for the metal are the factors that made it possible for our producers to deliver a record 319,024,872 lbs. of red metal worth \$96,632,633.

Estimates for the year 1960 indicate that 9 of the 13 "metallics" registered gains and 3 recorded a loss. There was no production of Mg in 1960.

The \$12,948,956 increase in the total value for industrial minerals was obtained mostly by gains recorded for asbestos and titanium oxide. The largest decrease was registered for lithium oxide, the value of which dropped from \$1,422,152 in 1959 to \$75,850 in 1960. However, as Quebec Lithium Corp. has placed its chemical plant in operation during the last quarter of 1960, lithium oxide could regain its lost ground.--From p. 1.

Mining operations are briefly summarized for New Quebec and North Shore, Chibougamau, Val d'Or, Rouyn-Noranda, and Montreal-Quebec districts, and district S. of the St. Lawrence.

3-3455. Quebec, Dept. Mines. LIST OF THE PRINCIPAL OPERATORS AND OWNERS OF MINES

AND QUARRIES IN THE PROVINCE OF QUEBEC: **Its: [Rept.] S-58, 81 p., 1961.**

Operators and owners are listed alphabetically, with addresses and locations of mines given.

3-3456. Alaska, Division of Mines and Minerals. **REPORT FOR THE YEAR 1960:** 88 p., 11 figs., 6 tables, Juneau, [1961?].

3-3457. Davis, Fenelon F., and others. **THE CALIFORNIA MINERALS INDUSTRY IN 1960:** California, Div. Mines, Mineral Inf. Service, v. 14, no. 3, p. 1-6, 6 illus., March 1961.

The value of total mineral production (metals, industrials, fuels) in California declined for the third successive year to \$1,411,000,000 according to recent cooperative estimate made by the California Division of Mines and the U. S. Bureau of Mines. This figure is 1% lower than the figure of \$1,424,000,000 reported in 1959. Au production continued to decline and reached the lowest level in 16 years. While natural gas production increased, petroleum production was relatively stable but was estimated to be off slightly from the previous year. A decline in the production of structural mineral materials was reflected in a similar decline in the industrial mineral group, although some industrial minerals may show an increase in output over 1959 when final figures are reported. Minerals in this borderline category are: borates, diatomite, potash, salt, and soda.--Auth.

3-3458. Pearre, Nancy C., and Allen V. Heyl. **CHROMITE AND OTHER MINERAL DEPOSITS IN SERPENTINE ROCKS OF THE PIEDMONT UPLAND, MARYLAND, PENNSYLVANIA, AND DELAWARE:** U. S. Geol. Survey, Bull. 1082-K, p. 707-833, 14 maps (8 in pocket incl. 3 col. geol.), 8 tables, 1960, 137 refs.

Serpentine in the area has been quarried for building, decorative, and crushed stone. Mineral deposits include chromite, titaniferous magnetite, rutile, talc and soapstone, amphibole asbestos, magnesite, Na-rich feldspar, and corundum.

Chromite occurs in massive, disseminated, and placer deposits. Several unusual minerals are associated with it. Production before 1900 from 27 of 40 known mines was 250,000-280,000 tons of ore. Placers produced well over 15,000 tons of concentrates. About 1,500 tons of ore was mined during World War I.

The chromite was used mostly for chemical purposes, before other uses were developed. Available analyses indicate that it would have satisfied modern chemical-grade requirements. Most contained too much Fe for the best metallurgical grade, but would have been satisfactory low-grade metallurgical chromite.

Deposits of titaniferous magnetite, once mined for Fe, are too small and low grade for potential sources of Ti. One rutile deposit has been prospected.

Talc and soapstone occur in shear zones or at contacts between serpentine and Na-rich pegmatites. Several deposits have produced steadily for years. Many small veins of tremolite and anthophyllite were

mined 1916-1940, but future asbestos production seems unlikely, except as a byproduct of talc quarrying. Magnesite veins are thin and small in comparison with other domestic deposits.

Na-rich feldspar and corundum occur in pegmatites that are unusual because they characteristically contain little or no quartz and mica and apparently are confined to serpentine rocks. Many of the known feldspar deposits are mined out. Interest in the corundum deposits is now largely mineralogical.--N. C. Pearre.

3-3459. Griswold, George B. **MINERAL DEPOSITS OF LUNA COUNTY, NEW MEXICO:** New Mexico, Bur. Mines & Mineral Resources, Bull. 72, 157 p., 24 figs., 10 pl. (in pocket, incl. 5 col. geol. maps), June 1961, 53 refs.

Luna County mines have produced \$8.64 million in minerals since the first recorded mining operations in 1876. The bulk of this production has been from Pb-Zn-Ag ores, but appreciable amounts of Mn, fluorspar, Cu, and Au also have been mined. The principal producing districts of the past were the Cooks Peak (Pb, Zn, Ag), Victorio (Pb, Ag), Tres Hermanas (Zn, Pb, Cu), Little Florida (Mn, fluorspar), and Fluorite Ridge (fluorspar). Lesser districts include the Fremont, Florida, and Cedar-Carrizalillo.

Mining is now at a standstill in Luna County because of the lack of known deposits that can be operated profitably under present market conditions. The full mineral potential of Luna County cannot be appraised accurately, but many factors point to at least the possibility of moderate-sized metalliferous ore finds in the Victorio, Tres Hermanas, and Cooks Peak districts. The fluorspar and Mn deposits offer promise only on radical improvement in the respective market prices involved.--Auth.

3-3460. van Geldern, J. **MINERAL AND MINING GUIDE TO WESTERN MEXICO:** 7 p., fold. map, Mineral Guide, Box 24232, Los Angeles 24, California, 1960.

The Sierra Madre mountain range in western Mexico has some of the most abundant metal and gemstone deposits known anywhere in North America. The range is a N.-S. trend of mountains of fairly young origin in which great folding took place followed by massive intrusions as well as minor volcanic action. Indications of heavy hydrothermal activity explain some of the abundance of ore deposits in the higher mountain regions. The western regions have been heavily leached and weathered, creating many rich secondary enrichment zones of ore at the water table.

Baja California is a younger range of mountains coinciding somewhat in age with the California Front Range, but of different origin. The whole region is quite heavily intruded by pegmatite dikes.

This guide for the layman briefly discusses the minerals, physiography, placer mining, placer regions, governmental regulations, and ore buyers and smelters. Map shows general locations for gemstones, placer Au, Au, Ag-Pb-Zn, and Cu.--L. M. Dane.

See also: Areal and Regional Geology 3-3202, 3-3207, 3-3209; Geophysics 3-3326; Geochemistry 3-3340, 3-3341, 3-3342; Sedimentary Petrology 3-3400; Geohydrology 3-3419; Mineral Deposits 3-3440, 3-3457; Miscellaneous 3-3559.

3-3461. Aleksin, A.G. **PRINCIPLES OF OIL AND GAS EXPLORATION**: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 4-A, p. 230-237, 1959, pub. 1961, 3 refs.

The successive stages of exploration, beginning with broad regional studies of an entire basin and its oil-bearing possibilities and ending with the detailed survey of individual deposits, are presented in tabular form. The importance of carrying out the work in a systematic way is emphasized in order to prevent negative results and increased costs, due to insufficient preliminary studies. The northwestern part of the middle Caspian oil-gas basin is mentioned as an example.--C. Voûte.

3-3462. Maksimov, M.I. **METHOD OF CALCULATION OF RECOVERABLE OIL RESERVES IN THE FINAL STAGE OF EXPLOITATION OF OIL STRATA UNDER CONDITIONS OF DISPLACEMENT OF OIL BY WATER**: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 3-B, p. 181-187, 4 graphs, table, 1959, pub. 1960.

Equations are proposed instead of the statistical method to calculate the recoverable oil reserves from oil strata. They are based on the relationship between extracted quantities of oil and water in the final stage of exploitation of an oil field, provided the oil is being displaced by water. The yearly yield of liquid and the final yield which still is deemed economical, as well as 2 coefficients, enter into the calculation of total oil reserves, remaining oil reserves, and also the time for extracting this oil. The data are checked by plotting them on a semi-logarithmic scale, which should give a straight-line relationship for the last phase of oil exploitation.--C. Voûte.

3-3463. Heemstra, R.J., and others. **LABORATORY EVALUATIONS OF NINE WATER TRACERS**: *Nuclear Science Abstracts*, v. 19, no. 1, p. 92, 94-96, fig., Jan. 1961, 10 refs. (not seen at AGI).

Evaluations were made of nine radioisotopes used as tracers to determine the subsurface flow of water in petroleum reservoirs. The isotopes evaluated were H^3 , I^{131} , Rb^{86} , Ir^{192} , Cr^{51} , Sb^{124} , In^{114} , Co^{60} , and Ce^{144} . Two principal requirements for such tracers are low loss through contact with solid petroleum-reservoir materials and stability in brine solutions. Tests were made by passing solutions through geological cores and measuring the activities of the solution after passage through the core and of the drained core materials. The results showed that 3 of the tracers tested should be useful water tracers: tritiated water, I^{131} , as the iodine ion, and Sb^{124} complexed with EDTA.--B. O. G. (courtesy Nuclear Science Abstracts, v. 15, no. 6A, p. 804, abs. 6226, March 31, 1961).

3-3464. Gurba, P.K. **METHODS OF DETERMINING THE TRUE WATER SATURATION OF AN OIL-BEARING STRATUM**: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 2-B, p. 119-121, table, 1959, pub. 1960.

A comparison of the results of a study on cores with actual production data from wells showed that

in several instances in the Soviet Pri-Carpathians water-free oil was produced from horizons, the cores of which apparently contained 50-70% water. Two different sets of conditions are thought to bring about this phenomenon. In practically impermeable rocks with permeability less than 0.1 millidarcy and a low porosity of 1-4%, subcapillary water is strongly bound to the rock and cannot be freed even by a considerable drop of pressure. On the other hand in poorly cemented rocks with a good permeability of 1-150 millidarcy and a high porosity with an average of 12-16%, drilling mud and its filtrate can penetrate freely into the pores and displace oil from the core. It is assumed that the mineralization of the bound water in the impervious beds would originally be about the same as in the more permeable parts of the same unit. In the case described there could not be any freshening of the bound water by percolating formation water. Taking these facts into account the true water saturation of cores prior to the penetration of drilling mud is calculated from the actual mineralization of water in the pores of the core. For this purpose the porosity of the rock is measured and an extract of the rock prepared in a known quality of distilled water. The salt content is determined by the specific resistance of the solution.--C. Voûte.

3-3465. Sinnokrot, Ali A., and George V. Chilingar. **EFFECT OF POLARITY AND PRESENCE OF CARBONATE PARTICLES ON RELATIVE PERMEABILITY OF ROCKS: A REVIEW**: *Compass*, v. 38, no. 2, p. 115-120, 5 figs., Jan. 1961, 8 refs.

Relative permeability is defined as the ratio of absolute permeability at a given saturation of a certain fluid to the permeability at 100% saturation of that fluid. The writers review some of the literature on the effect of polar substances in oil and the presence of carbonate particles on relative permeability of rocks. With increasing concentration of polar substances in oil the relative permeability to oil increases, but decreases with respect to water. The speed of adsorption of oil droplets to carbonate solid surfaces is greater than to quartz surfaces. Hence the relative permeability to oil is lower in a porous medium containing carbonate particles than in one made up of quartz grains.--Auth.

3-3466. Melik-Pashaev, V.S. **ON THE SO-CALLED TRANSITION ZONE IN THE DETERMINATION OF THE WATER-OIL CONTACT**: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 2-B, p. 114-118, 3 figs., 1959, pub. 1960, 2 refs.

The importance of an accurate determination of the oil-water contact, especially in platform areas with gently dipping strata, is emphasized, not only for a correct calculation of the oil reserves, but also for the planning of well-spacing and for the subsequent observation of the migration of the contact and for establishing the rate of oil recovery during development. In the northern Caucasus area, where the water-oil contact was determined from core-investigation data its position was clearly established. In other areas, such as the platform area of the Volga-Ural district, the contact was determined from geophysical logging data, from which the existence of an important transition zone was concluded. In some cases test wells produced pure oil from this zone and in others either oil with water or only water. The rocks of the water-bearing part of a stratum near an oil pool might contain a small amount of oil which occurs in a bound state. Inversely the oil satu-

ration of rocks is unequal within a given pool. Some water also occurs in the oil pool, which in part is connate and bound to the rocks. In part it is free moving and has penetrated into the oil pool from the underlying water-bearing beds by capillary action. The height of capillary rise of water which depends on the lithologic properties of the rock has to be studied by taking cores and determining their water content.--C. Voûte.

3-3467. Milesheina, A.G., and others. THE EFFECT OF MINERALOGIC COMPOSITION OF ROCKS ON PETROLEUM FILTERING THROUGH THEM: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 2-B, p.124-129, 2 figs., 5 tables, 1959, pub. 1960.

Laboratory experiments have been carried out in order to determine to what extent the mineralogical composition of a rock affects the qualitative composition of filtering petroleum. Use was made of artificial mineral mixtures of quartz sand with a size of 0.25-0.1 mm. with a 10% moisture content and with the addition of 5% by weight of montmorillonite, kaolinite, mica, microcline, and calcite. Natural petroleum was filtered through samples 130 mm. high and 28 mm. in diameter at a temperature of 20° and at a pressure drop of 0.085 atm. After each test the petroleum absorbed by the mineral mixture and the petroleum passing into the filtrate were studied chemically and by luminescence analyses. The analytical methods are described and the changes in quality of the filtered oil are shown in tables and photometric curves. The presence of clay minerals in rock lead to a decrease in the number of C atoms in the rings in the filtering petroleum and in the percentage of rings in the molecules of the naphthene-paraffin and of the aromatic hydrocarbons. An increase is noted of the C content in the paraffin side chains. The absorption of nonhydrocarbon components is favored by an addition of various minerals to the quartz sand.--C. Voûte.

3-3468. Altovsky, M.E., and others. ORIGIN OF OIL AND OIL DEPOSITS. Authorized translation from the Russian: 107 p., 16 figs., 29 tables, New York, Consultants Bureau, 1961.

A translation of *Obrazovanie Nefti i Formirovanie Neftnyanykh Zalezhei*, originally published in Moscow in 1958.

This work is considered by the authors to be a beginning of extensive investigations on the composition, conditions of migration, accumulation, and transformation of organic substances in subsurface waters and on the significance of these substances in the oil-forming processes; it is also thought to be a starting point in the study of the geochemistry of the elements closely associated with the chemical composition of subsurface waters.

The work is divided into 2 parts. The first part gives a critical evaluation of the existing views concerning the origin of oil (chiefly from the hydrogeological point of view), and a new hypothesis is proposed for the formation of the components making up natural petroleum in subsurface waters. The second part presents a brief summary of preliminary results in the study of organic substances and microflora in the subsurface waters of the Grozny-Dagestan region.

Since this book is designed not only for hydrogeologists, but also for geologists, chemists, and microbiologists concerned with the study of oil and natural

gas, the text has been considerably expanded, with data on vertical zoning and on the circulation of subsurface waters and the substances contained in them.

The entire first part of the book and the preliminary notes concerning the status of field investigations in the second part were written by M.E. Altovsky; the chapter in the second part concerning the content of organic material in the subsurface waters of the Grozny-Dagestan oil region was written by V.M. Shvets, and the chapter on the results of microbiological investigations in this same region was written by Z.I. Kuznetsova.--From pref.

3-3469. Yasenev, B.L. GASOMETRY OF WELLS AND ITS PROSPECTING IMPORTANCE: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 2-B, p. 105-108, 5 tables, 1959, pub. 1960.

The results are given of a study of the gas content of cores and mud samples, collected from boreholes situated both within oil and gas pools and in unproductive horizons. They were hermetically sealed upon recovery and heated in the laboratory to a temperature of 60-70°C. to extract the retained part of the absorbed and free gas. The gas was analyzed in a chromatographic analyzer and the light and heavy hydrocarbons determined separately. Although the gas content of the samples varied widely in relation to the lithology and permeability of the rocks and to the presence of syngenetic gas in some sediments, consistent differences were found suggesting a relation between gas anomalies and oil and gas pools. Within the area of oil and gas pools the gas content of the overlying sediments proved to be systematically higher than at the same stratigraphic horizon outside these areas. Moreover the gas in rocks over gas pools is mainly methane, but over oil pools it consists of heavy hydrocarbons. No increase of gas content with depth was observed however. The investigations included rocks from the Carboniferous, the Permian, the Jurassic, the Cretaceous, and the Neogene in the Krasnodar region and in the Kuybyshev and Saratov districts.--C. Voûte.

3-3470. Modelevsky, M.Sh., and V.I. Sheptunov. SOME POSSIBILITIES OF GAS LOGGING AFTER DRILLING: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 3-B, p. 187-191, 4 logs., 1959, pub. 1960, 2 refs.

A comparison is made between the results of gas logging during drilling and of terminal gas logging carried out after drilling while the casing is being driven. The latter method, which has certain advantages, consists of lowering the instrument to the desired depth and flushing of the well, while the gas content of the liquid is observed continuously. The method proved very useful in the upper Pechora region, where the Tournaisian-Visean sediments are characterized by rapid variations in thickness and in facies and many changes in porosity and permeability of the sandstone members. Under these conditions electrical logging (laterologging) does not accurately determine potential productive horizons.--C. Voûte.

3-3471. NATURAL GAS RECOGNIZES NO BARRIERS: *Oil & Gas Jour.*, v. 59, no. 17, p. 104, 106-108, 2 tables, Apr. 24, 1961.

A survey of gas occurrence of the world to see if any conclusions could be reached that would be useful in future gas exploration. The tables present a good picture of the habitat of natural gas today. The

first lists the major gas areas of the world along with reserves and geologic age of producing formations. The second table lists principal gas fields of North America by basin habitat, province, and reserves.--T. C. McLean.

3-3472. Turner, Daniel S. GAS TARGET FOR TOMORROW: Oil & Gas Jour., v. 59, no. 17, p. 148-150, 2 maps, graph, Apr. 24, 1961.

Black Mesa basin, northeastern Arizona, has come into focus as a possible gas area. The basin is a structural unit dipping inward toward a central focal point marked on the surface by the Cretaceous mesas. It resembles an archery target, wherein the Cretaceous, Mesa Verde, and Mancos formations form the bull's eye, surrounded concentrically by outcrops of the Jurassic, Triassic, and each of the Paleozoic systems except Ordovician and Silurian.

The general geology is discussed along with the possible reasons for the occurrence of He with natural gas. A generalized structure map shows more than 55 known structural features, as well as locations of gas shows.--T. C. McLean.

3-3473. GAS IN THE WILCOX LIES DEEP: Oil & Gas Jour., v. 59, no. 17, p. 110-111, 113, 2 maps, Apr. 24, 1961.

A general discussion of the Wilcox formation [Eocene] as encountered in S. Texas, followed by a more detailed description of the Northeast Thompsonville field, a typical deep Wilcox field.--T. C. McLean.

3-3474. Osmond, John C. NEW GAS PIPELINE SPURS UTAH BASIN EXPLORATION: Oil & Gas Jour., v. 59, no. 17, p. 130, 133-134, map, sec., table, Apr. 24, 1961.

The construction of a new 94-mi. pipeline by Mountain Fuel Supply Co. across the Uinta basin, Utah-Colorado, will open up large new areas for gas exploration and provide a needed outlet for presently producing wells.

The Uinta basin is an area defined to the S. by the Book Cliffs and on the N. by the Uinta Mountains. The eastern flank is marked by the Douglas Creek arch in western Colorado.

Many possible gas and/or oil sands exist in a thick series of sediments ranging in age from Cambrian to Cretaceous in age. This article gives a description of the geology as known today and discusses future possible "pay" areas.--T. C. McLean.

3-3475. Skeeters, W. W. GAS IS MAJOR TARGET FOR EXPLORERS IN THE GREEN RIVER BASIN: Oil & Gas Jour., v. 59, no. 17, p. 152-154, 158, map, Apr. 24, 1961.

The Green River basin is bounded by the Overthrust belt on the W., the San Madres Mountains and Rowlins uplift on the E., the Wind River and Gros Ventre Mountains on the N., and the Uinta Mountains and axial basin anticline on the S. This area involves 21,000 sq. mi. in Wyoming, Utah, and Colorado.

Discussed are the Rock Springs uplift, the Big Piney platform, Church Buttes, Wamsutter arch, and Vermillion basin. Subdivision of the basin into these smaller components is shown.--T. C. McLean.

3-3476. Zhdanov, M. A. PROBLEM OF CALCULATION OF CASING-HEAD GAS RESERVES: Geologiya

Nefti - Petroleum Geology, in translation, v. 3, no. 3-B, p. 177-180, 1959, pub. 1960, 2 refs.

Briefly discusses methods to calculate reserves of extractable gas dissolved in oil deposits. The methods using the gas/oil ratio and its dynamic changes are not very satisfactory, because the factors governing the solubility of gases in oils of various compositions are not taken into account. The total amount of gas liberated depends on the process of degasification, and therefore the reserves of gas must be determined according to data obtained from deep or formation tests of oil. Several equations are given to calculate the extractable reserves for oil deposits with a water drive, with a dissolved gas drive and for oil reserves with a gas cap. These equations figure the extractable reserves of oil, balanced reserves of oil, unextractable reserves of oil, initial solubility of the gas, volume coefficients of the formation oil at the beginning and at the end of the exploitation, initial and residual pressures, temperature corrections, and the specific gravity of the oil at standard conditions.--C. Voûte.

3-3477. Donnell, John R. TERTIARY GEOLOGY AND OIL-SHALE RESOURCES OF THE PICEANCE CREEK BASIN BETWEEN THE COLORADO AND WHITE RIVERS, NORTHWESTERN COLORADO: U.S. Geol. Survey, Bull. 1082-L, p. 835-891, 3 figs., 12 pls. (7 in pocket incl. geol. map, scale 1:125,000), 5 tables, 1961, 44 refs.

The part of the Piceance Creek basin mapped is an area of about 1,600 sq. mi. that is in general characterized by a plateau that rises 1,000 to 4,000 ft. above the surrounding lowlands. Rocks in the area range in age from the Upper Cretaceous Mesaverde group to the middle Eocene Green River formation.

The Green River formation has been divided into the Douglas Creek, Garden Gulch, Anvil Points, Parachute Creek, and Evacuation Creek members. The principal exposed oil-shale beds around the margin of the basin are in the Parachute Creek member. At and near the center of the basin the lateral equivalents of the Douglas Creek, Garden Gulch, and Anvil Points members also contain rich oil shale, and a continuous sequence of shale 2,000 ft. thick will yield an average of 15 gallons of oil per ton.

More than 7,000 million barrels of oil are contained in shales that will yield an average of more than 45 gallons of oil per ton, about 160,000 million barrels in shales yielding an average of more than 30 gallons of oil per ton, about 310,000 million barrels of oil in shales yielding an average of more than 25 gallons of oil per ton, and more than 900,000 million barrels of oil in shales that yield an average of more than 15 gallons of oil per ton.--Auth.

3-3478. Veber, V. V., and A. I. Gorskaya. ON THE ALGARITES OF AZERBAIDZHAN (CONCLUSION): Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 2-B, p. 130-133, 2 tables, 1959, pub. 1960, 14 refs.

Continuation of GeoScience Abstracts 3-979. A description is given of the Kotur-Dag mud volcano, where algarite crusts are also found. The crater differs from the other mud-volcanoes of the southeastern Caucasus by the very slow but practically uninterrupted discharge of a thick, nonuniform breccia with inclusions of solid rock fragments, which flows down the flanks of the volcano like a glacier at a rate of nearly 2 m. per year. The algarite crusts occur at the zone of contact of the fresh mud-

volcano breccia with the crater rims at the most probable path of emission of gas. They are of secondary origin and seem to be connected with the action of bacteria consuming methane gases. The crusts contain an active microflora which is facultative-anaerobic. The crusts contain a little bitumen which differs considerably in its composition from the bitumen contained in the mud-breccia and brought up from depth. It is concluded that the algarites, which show much in common with the "paraffin dirt" described by American geologists, in some cases might be formed in the process of decomposition of the paraffin hydrocarbons of petroleum. In other instances, however, they are the products of bacteria consuming methane with an admixture of heavy hydrocarbons, which is petroliferous gas, and not pure methane.--C. Voûte.

3-3479. Jardine, D., and others. DEVELOPMENTS IN EASTERN CANADA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 986-992, 6 figs., 6 tables, June 1961.

During 1960 development drilling in Ontario increased over 1959, but exploratory drilling decreased slightly. Offshore activity (exploratory and development combined) decreased by 50%. Oil production reached a new peak of 1,005,000 bbls., very slightly greater than 1959. Natural gas production also increased slightly to 16,900,000 Mcf.

Drilling in Quebec was greatly curtailed, with only 1 deep completion. Activity also slackened in the Maritimes where 3 dry exploratory wells were drilled.

Four significant discoveries were made in southwestern Ontario, 1 each in Essex, Oxford, and Wentworth counties and 1 offshore from Welland County in Lake Erie.

Acreage held by industry decreased significantly in almost all areas, and field-party activity, both geological and geophysical, decreased by approximately 50%.--Auth.

3-3480. Latus, Thomas J. DEVELOPMENTS IN WESTERN CANADA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 974-985, 2 maps, 7 tables, June 1961, 11 refs.

Exploration and development activities in western Canada during 1960 showed an over-all decline although expenditures are estimated to have decreased only slightly owing to deeper, more costly drilling and increased exploration drilling and seismic in the remote northerly regions. Alberta still led the other provinces by substantial margins in all phases except surface mapping.

There was a slight decrease in the over-all number of wells drilled from 2,551 to 2,516. Exploratory tests, which accounted for a slightly smaller percentage of the total, declined 13% to 818. Success of exploratory drilling remained at 30% and gas discoveries (147) again exceeded oil discoveries (102). The Northwest Territories recorded its first gas discovery and other important gas finds were made in the foothills of the Rocky Mountains and northeastern British Columbia. Development drilling centered mainly in the oil fields of Pembina and Swan Hills region, Alberta, and southeastern Saskatchewan.

Exploration was marked by increased activity in the northern regions and a severe decline in Saskatchewan. Geophysical work continued to decline, down 16% to 563 months compared with 1959's 30% decline; and surface mapping also declined for the first time

(down 22% to 280 months).

Crude oil production reached a new high of 192 million bbls., up 4 1/2% on 1959 for a cumulative of 1.46 billion bbls. Gas production was up 22% to 585 BCF for a cumulative of 4.55 TCF. Liquid hydrocarbon remaining reserves increased by about 216 million bbls. to 4.2 billion bbls., a 5 1/2% increase as compared with a 10 1/2% increase in 1959; gas reserves showed a 16% increase to 30.5% TCF. Sulfur reserves increased 8% to 55 million long tons. Final approvals were given during the year for the export of 800 million cu. ft. of gas per day into the United States.

Land holdings decreased slightly by 4% to 256 million acres mainly as a result of surrenders on the mainland (57 MM acres) being offset to a large extent by new holdings (47 MM acres) in the Arctic Islands.--Auth.

3-3481. DeBlois, Roland, and others, comps. DATA ON WELLS DRILLED FOR PETROLEUM AND GAS IN THE GASPÉ PENINSULA: Quebec, Dept. Mines, [Rept.] S-53, 81 p., fold. map (no. 1349), scale 1:253,440, 1960.

This report gives the main facts on most wells drilled for petroleum and natural gas in the region concerned up to the close of 1959. For each well, data include: location of the boring; name of the well and company for which the work was done; name of contractor who did the work; elevation at the site of the well; dates of commencing and terminating the work; type of drill used; depth and the importance of the various water, gas, and petroleum occurrences; geological analyses of the different formations traversed, etc. Map shows location of all wells described.--Quebec, Dept. of Mines.

3-3482. Carsey, J. Ben. EXPLORATORY DRILLING IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 701-727, 8 figs., 20 tables, June 1961.

During 1960, 11,704 exploratory holes were drilled in the United States; 2,189 of these produced some oil or gas representing 18.70% of all exploratory effort. There were 7,320 new-field wildcats, 745 of which produced some oil or gas, representing 10.18% of all new-field wildcats. New-pool tests (including new-pool wildcats, deeper-pool tests, and shallower-pool tests) for 1960 totaled 1,953 holes, 616 or 31.54% of which produced some oil or gas. There were 2,431 outposts; 828 of them, or 34.06%, produced some oil or gas.

The total exploratory footage drilled in the United States in 1960 was 55,830,684 ft. in the 11,704 holes, or 4,770 ft. per hole. These figures compare with 63,252,521 ft. drilled in 13,191 exploratory holes, with an average depth of 4,795 ft. in 1959.

For the second time data are presented on natural gas reserves in the 17-states area by years, for discoveries having 6 years of development history.

Only about 2% of all new-field wildcats discover a profitable field, although 11-12% are "successful" in that they produce some oil or gas.

For the thirteenth time, data are presented on Canada and Mexico.--Auth.

3-3483. Richards, Horace G. DEVELOPMENTS IN ATLANTIC COASTAL STATES BETWEEN NEW JERSEY AND SOUTH CAROLINA IN 1960: Am Assoc.

Petroleum Geologists, Bull., v. 45, no. 6, p. 910-911, June 1961, ref.

Geophysical exploration has been reported from the continental shelf off New Jersey, North Carolina, and South Carolina. One test well was drilled on the Coastal Plain of Virginia and 3 in North Carolina. New wells were drilled in Buchanan, Dickenson, and Wise counties, in western Virginia. Production of gas was reported from western Maryland and western Virginia with a small amount of oil from the Rose Hill field in Lee County, Virginia.--Auth.

3-3484. Harrell, David C., and William D. Lynch. DEVELOPMENTS IN SOUTHEASTERN STATES IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 903-909, 2 maps, 3 tables, June 1961, 12 refs.

Mississippi was the most active of the southeastern states during 1960; 700 wells were drilled, an increase of 6.5% over the previous year. Nineteen oil fields and 3 gas fields were discovered in the state. The productive zones in the new fields are classified as follows: Tertiary (4 Wilcox oil fields), Upper Cretaceous (1 Selma chalk oil field, 1 Eutaw oil field, and 9 lower Tuscaloosa oil fields), Lower Cretaceous (2 Rodessa oil fields, 1 Hosston oil field, 1 Washita-Fredericksburg gas field, and 1 Paluxy gas field), Paleozoic (2 Mississippian fields). There were 19 new-pool discoveries and 13 field extensions during 1960. The most active field development was seen at McComb in Pike County, where 133 oil wells were completed.

Of the 49 wells drilled in Alabama, 33 were development wells in the Citronelle field.

Four deep unsuccessful Lower Cretaceous wildcat wells were drilled in Florida. One was in the extreme northwestern part of the state; 1 was 6 mi. W. of the Sunniland field, in the southern part of the peninsula, and 2 were offshore in the shallow waters of the Gulf of Mexico.--Auth.

3-3485. Martz, Walter H., Jr. DEVELOPMENTS IN NORTH MID-CONTINENT IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 795-801, map, 7 tables, June 1961.

During 1960, there were 4,187 wells drilled for oil or gas in Kansas. Of this number, 54.6% were successful. Production in Kansas for 1960 amounted to 113,344,548 bbls. of oil, 4,862,277 bbls. of natural gasoline and LPG, and 632,609,850 MCF of natural gas.

Exploratory tests in Kansas during 1960 numbered 1,104, including 97 oil discoveries, 21 gas discoveries, 75 extensions to oil pools, 22 extensions to gas pools, and 889 dry holes. New-field, new-pool, and outpost discoveries numbered 107 during 1960; this figure includes 7 discoveries which resulted from old holes worked over. There were 17 deeper-pool discoveries and 1 shallower-pool discovery during 1960.

Available information indicates that 22 exploratory tests were drilled during 1960 in Iowa, Missouri, and that part of Nebraska E. of the 98th Meridian. None of these 22 tests was successful.--Auth.

3-3486. Popenoe, H.L. DEVELOPMENTS IN WEST COAST AREA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 959-973, 4 figs., 6 tables, June 1961.

Washington: Five exploratory wells were drilled

and abandoned. Total exploratory footage was 23,849. Crude oil production in 1960 was 898 bbls.

Oregon: Five unsuccessful new-field wildcats were drilled. Total exploratory footage was 19,212.

California: Four hundred twenty-nine exploratory wells were drilled in California during 1960 compared with 498 during the preceding year. Total exploratory footage was 2,441,111. The average depth per well was 5,690 ft. vs. 5,568 ft. per well in 1959. Seventeen new fields, 4 oil and 13 gas; and 26 new pools, 11 oil and 15 gas, were discovered. Exploration was 16.3% and 19.3% successful as to wells and footage respectively, compared with 17.4% and 18.9% in 1959. Crude oil production in 1960 was 304 million bbls., down 1.1% from 1959. Natural gas production was 500.5 billion CF, and production of gas liquids was 28.4 million bbls. Basement was reached in 21 unsuccessful exploratory wells. There were 38 active exploratory wells at the end of the year.--Auth.

3-3487. Bruce, Donald D. DEVELOPMENTS IN ALASKA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 993-998, 2 maps, 2 tables, June 1961, 36 refs.

Exploratory and development drilling operations increased considerably during 1960, while surface mapping and geophysical activities showed a substantial decrease during the year. Thirty-one wells were active during 1960, compared with 20 in 1959. Ten exploratory wells and 16 development wells were spudded during the year, representing increases of 25% and 100%, respectively, over the previous year. One new gas field, 2 major step-outs, and 1 new gas zone were discovered in 1960.

Eighteen oil companies had surface parties in the field during the year. At the close of 1960, there were approximately 34,000,000 acres under Federal oil and gas leases and 117,203 under state of Alaska oil and gas leases. Surface mapping and geophysical activity in 1961 should remain at the 1960 level, and drilling activity should increase substantially during the coming year.--Auth.

3-3488. Budd, Harrell. DEVELOPMENTS IN ARIZONA AND WESTERN NEW MEXICO IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 948-958, 2 maps, 5 tables, June 1961.

In 1960, 729 holes were drilled in the Arizona and western New Mexico district. This represents a decrease of 15.1% from the 1959 total of 977 holes. Of the 1960 total, 129 were exploratory that resulted in 44 successful discoveries and extensions. As a result this district enjoyed a success ratio of 34.1%.

The majority of exploratory drilling was directed toward extending previously discovered pools in the deeper part of the San Juan basin. Here the petroleum geologist was best utilized, and as a result the success ratios were abnormally high. In the Lucero basin of W.-central New Mexico and the Black Mesa basin of northeastern Arizona, surface exploration continued to be the primary tool and resulted in at least one new-field discovery in a new pay zone. Future exploration will be directed toward investigation of the Cretaceous rocks in the shallower parts of the San Juan basin and the Paleozoic rocks of the Black Mesa and Lucero basins.

There were 13,133,237 bbls. of oil, 373,811,159 MCF of gas, and 1,484,166 bbls. of condensate produced in the Arizona and western New Mexico district in 1960.--Auth.

3-3489. Jenkinson, Lewis F., and Richard P. Sevier. DEVELOPMENTS IN ARKANSAS AND NORTH LOUISIANA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 889-902, 3 figs., 7 tables, June 1961, 12 refs.

This report covers a part of the Gulf Coastal Province located in N. Louisiana and Arkansas, and the Paleozoic area of northwestern Arkansas. The district includes 26 parishes of N. Louisiana and all of Arkansas.

There was a decrease in drilling activity in 1960 as compared with the previous year. In N. Louisiana, the decrease in the number of wells drilled was due to the lack of development drilling. Exploration activity increased slightly over 1959. Arkansas showed a marked decrease in both development and exploration drilling activity.

Twenty-one new fields were discovered in N. Louisiana and 5 new fields were discovered in Arkansas. As in the past, sandstones of the Wilcox formation accounted for the largest number of new-field discoveries in N. Louisiana. Four of the new-field discoveries in Arkansas were in sandstones of the Atoka formation of Pennsylvanian age.

The most important exploration activity in Arkansas was in search of gas in the Arkoma basin in the northwestern part of the state. Exploratory drilling was dominant in the Wilcox and Tuscaloosa areas in the eastern part of N. Louisiana and in the western part searching for Paluxy pools. Interest was again shown in the Hosston and Cotton Valley of Jackson, Lincoln, and Ouachita parishes.

Exploration activity will probably remain about the same during 1961 as was present in 1960. Arkansas' activity will be centered in the Arkoma basin while activity in N. Louisiana will again be centered in the Wilcox, Tuscaloosa, Hosston, and Cotton Valley sandstone-trend areas.--Auth.

3-3490. Bibb, Thomas W., Jr. DEVELOPMENTS IN COLORADO AND WESTERN NEBRASKA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 938-947, map, 5 tables, June 1961, 6 refs.

Total wells drilled (906) in Nebraska during 1960 represented a 5% decrease from 1959, although exploratory drilling increased 6.1%. Success ratio for wildcat wells was 10.4%. Most significant were 6 new fields discovered on the W. flank of the Cambridge arch, where in addition to Lansing-Kansas City production, "Reagan" sand (Cambrian(?)) was found productive at Sleepy Hollow. Total production in western Nebraska for 1960 was 23,921,487 bbls., an increase of 5.9% over the 22,584,096 bbls. produced in 1959. The Denver basin production increase amounted to only 2.6%, whereas Cambridge arch production increased over 806%.

Drilling in Colorado totaled 703 wells, a decline of 16.1% from 1959. Exploratory drilling in eastern Colorado decreased 76.7%, while wildcat wells in western Colorado increased 11.8% over 1959. Success ratios for the 2 areas were 11.9% and 16.7%, respectively. Foremost in importance was the discovery of gas and condensate from the Mississippian and Devonian rocks at SE. Lisbon in the Colorado part of the Paradox basin. Six gas fields and 2 oil fields were found in NW. Colorado, including a significant Weber (Pennsylvanian) discovery on the Danforth Hills anticline and several Cretaceous Mancos-Mesaverde transition zone gas discoveries. Total production in Colorado for 1960 was 47,427,297 bbls., a 2.1% increase of 973,885 bbls. over the 46,453,412 bbls. produced in 1959.

Geophysical activity increased sharply on the Cambridge arch, S.-central Nebraska, and in the Paradox basin of SW. Colorado, the latter area accounting for 54% of total seismic work in Colorado and Nebraska. These same areas provided the most active regions, leasing and trading-wise.

The decline in Denver basin Cretaceous exploration, which was sharply down in 1960, is expected to continue during 1961. However, this will undoubtedly be offset by continued increased activity in western Colorado and on the Cambridge arch of S.-central Nebraska.

Changes during 1960 in the Mineral Leasing Act involving increased annual rentals of Federal lands will probably cause a more rapid evaluation of such lands during 1961.--Auth.

3-3491. Bell, Alfred H., and Jacob Van Den Berg. DEVELOPMENTS IN ILLINOIS IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 769-777, 2 figs., 8 tables, June 1961.

In Illinois, 1,922 wells were drilled for oil and gas in 1960, a decrease of 5% compared with the 2,032 total in 1959. These figures are exclusive of water- or gas-input wells, salt-water disposal wells, and old wells worked over.

Exploratory drilling increased 23.6% from 535 wells in 1959 to 661 in 1960. Eleven new pools, 43 extensions, and 26 new pays in pools were discovered in 1960. Total oil production increased from 76,727,000 bbls. in 1959 to 77,341,000 bbls. in 1960.

Of the 11 new pools discovered in 1960, 5 oil pools and 1 gas pool produced from Mississippian sandstones and limestones, 2 oil pools from limestone of Devonian age, and 3 from carbonates of Silurian age.--Auth.

3-3492. Carpenter, G. L., and Howard Smith. DEVELOPMENTS IN INDIANA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 778-781, map, 3 tables, June 1961.

Oil production in Indiana totaled 12,054,000 bbls. during 1960; this figure represents an increase of 4.1% over the 1959 production of 11,554,000 bbls. During 1960, there were 1,072 wells drilled, an increase of 18.0% over the 910 wells drilled in 1959. Of this total, 394 were wildcat wells and 678 were field-development wells.

Thirty-four of the wildcat wells were successful: 15 were new pools, 17 extensions to pools, and 2 new pay zones in productive areas. Twenty-six of these wells were completed in rocks of the Mississippian system, 4 in the Pennsylvanian, 1 in the Devonian, and 3 in the Ordovician.

Most of the wells drilled during the year were in the southwestern counties of the state and were drilled to test reservoirs in rocks of the Chester series. Approximately 44% of the exploratory effort of 1960 took place in Spencer County alone.

Interest in the possibility of deeper production was evidenced by the drilling of several sub-Trenton tests in the state during the year.--Auth.

3-3493. Sullivan, Dan M. RECENT OIL DEVELOPMENT IN SPENCER COUNTY, INDIANA (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Fourth Annual Meeting, June 3, 1960: Kentucky, Geol. Survey, Ser. 10, Spec. Pub. 3, p. 48-55, sec., graph, table, 1960) 5 refs.

Spencer County, which is situated along the E. margin of the Illinois basin in Indiana, has been an area of accelerated activity in recent years. Although oil was discovered in Spencer County in the late 1920's, the county did not receive concentrated interest until activity in the flank areas of the Illinois basin began to increase in the 1950's. A high level of exploratory activity should continue as production discovered in the shallow reservoirs in Spencer County and adjacent counties compares favorably with production from the same reservoirs in the deep part of the Illinois basin.--Auth.

3-3494. Nosow, Edmund. OIL AND GAS DEVELOPMENTS IN KENTUCKY IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 761-766, 4 tables, June 1961.

Oil production in Kentucky amounted to 21,146,950 bbls., showing a decline of more than 6,000,000 bbls., directly attributable to the drop in Green County. Gas production reached a new peak of 73,896,526 MCF, western Kentucky accounting for 1,872,009 MCF. Deep tests were completed by United Fuel Gas Company in Bell and Elliot counties, and Ralph Thomas drilled a basement test in Lewis County. Interest in Knox production continued to stimulate deep drilling in eastern and central Kentucky. The new oil and gas law which went into effect in June was the greatest forward step Kentucky has taken in its entire history of oil and gas production.--Auth.

3-3495. Thomas, George R. GEOLOGY OF RECENT DEEP DRILLING IN EASTERN KENTUCKY (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Fourth Annual Meeting, June 3, 1960: Kentucky, Geol. Survey, Ser. 10, Spec. Pub. 3, p. 10-28, 8 figs., 1960)

The United Fuel Gas Co. and others have in the past 2 years drilled 6 deep wells in eastern Kentucky and one in western West Virginia in quest of oil and gas from the lower Paleozoic sediments. Nearly two million dollars has been spent in the drilling of some 65,000 ft. of hole.

No commercial production has been found, but numerous oil and gas shows indicate that the area has a very good potential in the Cambro-Ordovician carbonate section known locally as the "Knox dolomite."

A deep basin was found in the Lower and Middle Cambrian sediments which is correlated with the Rome formation on outcrop to the S. in Lee County, Virginia.

A basement structural high was located in north-eastern Kentucky, which was overlain by a basal sand exhibiting good porosity. This sand may correlate with the Mt. Simon sand of Ohio.

The Knox dolomite section thins from 2,500 ft. in Bell County, southeastern Kentucky, to less than 1,100 ft. in Lewis County, northeastern Kentucky. Water was encountered in all good porous zones which indicates that production from this thick dolomite section will probably be similar to that of most of Kentucky's shallow oil and gas fields, in that available porosity or stratigraphic condition, rather than structural position, will be the controlling factor in its location.--Auth.

3-3496. Patterson, Reid. AN INTERPRETATION OF RECENT DISCOVERIES IN KENTUCKY'S ALLEN COUNTY AREA: (In: McGrain, Preston, and Thom-

as J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Fourth Annual Meeting, June 3, 1960: Kentucky, Geol. Survey, Ser. 10, Spec. Pub. 3, p. 56-62, 5 maps, 1960)

Within or near Allen County there have been 5 important oil discoveries since Sept. 1959, 4 of which are herein briefly described. In an area where geological data have long been ignored, and at time belittled, it is significant that favorable structural conditions are associated with each of the 4 accumulations.

Domal closure characterizes 3 new pools of the Allen County area, and fault trapping is evidently responsible for the fourth. Of the anticlinal traps, one produces from the Laurel, one from both the Laurel and the Lego, and one from an undetermined formation. The Lego limestone is the productive formation in the faulted area.

Although the pools have not proved large and production has not been uniformly impressive, the geological facts obtained may well have important implications regarding the future of exploration in S. central Kentucky.--Auth.

3-3497. Knodell, John D., Jr. THE KENTUCKY OIL AND GAS CONSERVATION ACT OF 1960 (In: McGrain, Preston, and Thomas J. Crawford, eds. Proceedings of the Technical Session, Kentucky Oil and Gas Association, Twenty-Fourth Annual Meeting, June 3, 1960: Kentucky, Geol. Survey, Ser. 10, Spec. Pub. 3, p. 38-47, 1960)

Although Kentucky was blessed with the first commercial oil well in the United States, it is the most recent oil and gas producing state to adopt a comprehensive oil and gas conservation act. The new Kentucky Act adopted by the legislature in Feb. 1960, is the culmination of industry efforts commencing in 1940 to formulate an acceptable bill. The new Act requires well permits, establishes spacing and pooling, creates the office of Director of Oil and Gas Conservation and, to a limited extent, defines and prohibits physical waste.

The new Act prohibits drilling or deepening a well unless a permit is obtained from the Dept. of Mines and Minerals and establishes a permit fee of \$25 for each producing well and \$10 for each injection well. Existing provisions protecting coal owners and operators in coal areas have been retained.

The statute prohibits drilling for oil less than 200 ft. from the nearest lease boundary and requires any well located less than 400 ft. from the nearest lease boundary to be at least 400 ft. from the nearest well. For gas wells the corresponding distances are 500 and 1,000 ft. Exceptions to the spacing requirements are provided for topographical reasons, for injection wells, for producing wells in established flood programs, and for protection of correlative rights. Pooling is permitted only when requested by the owner of a small tract and then only if such owner desires to drill a well on his own tract or if an adjacent operator desires to drill a well on his own tract or if an adjacent operator has requested a permit for a well within 400 ft. of the small tract. Once the request is made, the Director (after notice and hearing) establishes one pooled unit no larger than the area necessary to provide one location for the drilling of oil or gas, as the case may be. Except for that limitation on the size of the pooled unit, the Director has complete discretion in fixing the boundaries of the unit.

The new Director of Oil and Gas Conservation is

an officer in the Dept. of Mines and Minerals under the direct supervision of the head of the Dept. The Director will be delegated all of the responsibilities for administering the oil and gas Act. The Act permits the Dept. to require identification of leases and the making and filing of reports, and it is the duty of the Dept. to regulate drilling and plugging of wells, the use of vacuum, and the prevention of waste. The Dept. is given the authority to promulgate rules and regulations to govern in these areas of statutory authority.

While the new Act is not a complete oil and gas conservation measure, it is a real step ahead for Kentucky, one of the older producing states. The bill is destined to be a successful conservation measure, for it is the result of the cooperation of all segments of the oil and gas producing industry in Kentucky. It is certainly adequate to solve the major problems besetting oil and gas producers in Kentucky's present state of development.--Auth.

3-3498. Vidrine, Louis O., and H. A. Vallas. DEVELOPMENTS IN LOUISIANA GULF COAST IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 879-888, 2 figs., 7 tables, June 1961, 14 refs.

The Louisiana Gulf Coast, as treated in this analysis, consists of the 38 southern parishes and the 16 adjacent continental shelf areas offshore. Production is obtained from sediments ranging in age from Cretaceous to Pleistocene.

The 2,251 development and exploratory wells drilled in 1960 are favorably comparable in number and in results with those of 1959. Of the 769 exploratory wells, 44.4% were successful. The SE. district continued to be the most important in both development and exploratory drilling. The offshore district had a 69.4% increase in exploratory drilling.

Of the 50 new-field discoveries (42 onshore, 8 offshore) the most important are: South Chauvin field, Terrebonne Parish; Pierre Pass field, Assumption Parish; and Eugene Island Block 100 field. The most important of the 292 new pools and extensions include Buck Point field, Vermilion Parish, and South Pass Block 27 field.

Leasing continued to be very active, with large blocks of acreage being assembled and traded. Sub-surface geology increased in importance as more well control became available. Seismic exploration continued to be extensive. In 1960, the high level of activities recorded in 1957 and 1959 was maintained.--Auth.

3-3499. Ives, Robert E., and Garland D. Ellis. DEVELOPMENTS IN MICHIGAN IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 782-794, 4 figs., 4 tables, June 1961, 7 refs.

Michigan registered its greatest yearly increase in drilling activity in 10 years. There were 832 completions as compared with 598 in 1959. Of the 1960 total, 564 were development wells and 268 were exploratory wells. The development wells resulted in 361 oil wells, 15 gas wells, and 188 dry holes. Exploratory wells resulted in 15 discoveries and 253 dry holes. Total drilled footage for oil and gas tests including deepenings was 2,986,810 ft.; classified as exploratory 975,705 ft. and development 2,011,105 ft. In 1959 the footage drilled was 1,919,633 ft. There were 15,899,205 bbls. of oil and 19,240,168 MCF gas produced during the year.

Gravity crews numbered as high as 14 at various times during the year, with 2 and 3 seismic crews

also being active. The geophysical activity was concentrated around the flanks of the Michigan basin. Major oil companies, independents, and brokers carried on a very active lease play throughout the year.

The major drilling activity was the development in S.-central Michigan relative to the Albion-Pulaski-Scipio-Trenton-Black River fracture trend. Two hundred and thirty-six wells were completed along the "trend" during 1960, and 7,921,989 bbls. of oil and 10,581,543 MCF of gas were produced. The Niagara reef developments in eastern Michigan also claimed a large share of the activity.--Auth.

3-3500. Burton, Robert H., and John R. Dyer. DEVELOPMENTS IN MONTANA, NORTH DAKOTA, AND SOUTH DAKOTA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 912-925, map, 10 tables, June 1961.

Exploratory drilling in 1960 showed a sharp rise in Montana and a sharp drop in North Dakota. The success ratios however were greater in North Dakota than in Montana. Seismic activity reflected the same pattern as did exploratory drilling in Montana showing a sharp increase and North Dakota a sharp drop. At the end of the year considerable interest was developing along the western flank of the Williston basin bordering the Montana-North Dakota state line.--Auth.

3-3501. Foster, Roy W., and others. PETROLEUM DEVELOPMENTS IN NEW MEXICO DURING 1959: New Mexico, Bur. Mines & Mineral Resources, Bull. 73, 169 p., 12 tables, June 1961.

Petroleum is the most important mineral industry in New Mexico, providing slightly over 70% of the total value of all minerals produced in the state. The 1959 production of crude oil and distillate amounted to 104,946,969 barrels, an increase of almost 6 1/2 million barrels over the previous record high production of 98,514,926 barrels, set in 1958. Production of natural gas totaled 743,040,175,000 cu. ft., an increase of about 12 billion cu. ft. over the previous record high year of 1958, when 726,236,763,000 cu. ft. was produced. New Mexico ranks seventh in the production of crude oil and third in the production of natural gas in the United States.

Wells completed during the year numbered 2,103, an increase of 284 tests over 1958. The total footage drilled in the state increased only slightly to 8,724,066 ft. in 1959, compared with 8,453,268 ft. in 1958. The average depth per well decreased from 4,647 ft. in 1958 to 4,148 ft. in 1959.--Auth.

3-3502. Roswell Geological Society. THE OIL AND GAS FIELDS OF SOUTHEASTERN NEW MEXICO, 1960 SUPPLEMENT. A SYMPOSIUM. Edited by Henry N. Sweeney, and others: 229 p., 62 maps (5 fold.), 4 charts, profile, 4 secs., diag., tables, Roswell, New Mexico, 1960, pub. 1961, refs.

A supplement to The Oil and Gas Fields of Southwestern New Mexico, published by the Roswell Geological Society in 1956. Important discoveries in the Delaware basin and shelf areas, and in the lower Permian, Pennsylvanian, and Devonian throughout the area have given a new direction to exploratory drilling. In particular, recent developments have indicated production of major importance in the Abo Reef trend and lower Pennsylvanian sands.

The following papers are included in the introductory material.

- Review of Petroleum Exploration in Southeastern New Mexico, by Phil D. Helmig.
 Drilling Activity in Southeast New Mexico During 1960, from Rinehart's Oil Report.
 Abo Reefing in Southeastern New Mexico, by William J. LeMay.
 Lower Pennsylvanian Gas Exploration, Eddy County, Southeastern New Mexico, by Frank Podpechan.
 Major Structural Features and Geologic History of Southeastern New Mexico, by T. F. Stipp.
 Recent Upper Bell Canyon Exploration in the North Delaware Basin, by Marsh Nottingham.

Production to July 1, 1960 of fields included in 1956 Symposium is given in tabular form. The main part of this symposium consists of data on approximately 150 oil and gas fields of southeastern New Mexico which represent new fields or major revisions since May 1956. Information covers discovery well; pay zone; typical core analysis of a pay interval in the field; other shows encountered in the field; trap type; nature of oil, gas, and producing zone water; initial field pressure; type of drive; and normal completion practices. Production data are given in tabular form.
 --L. M. Dane.

- 3-3503. Kreidler, William Lynn. GAS AND OIL DEVELOPMENTS IN NEW YORK STATE, 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 728-733, map, 3 tables, June 1961.

In 1960, there was a 60% increase in drilling for natural gas over 1959. Forty-seven wells were completed to the Medina gas sand, of which 7 may be discovery wells of new Medina gas pools. There were 296 oil-field development wells drilled during 1960.
 --Auth.

- 3-3504. Alkire, Robert L., and others. OIL AND GAS DEVELOPMENTS IN OHIO IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 749-756, map, 10 tables, June 1961.

This year, 1,016 wells were completed, of which 707 wells were successful and 309 dry; a percentage of 30.4 failures. Activity and results in the Clinton sand are favorably comparable with wells drilled to this horizon in past years.

Exploratory tests totaled 61, of which 23 were successful and 42 dry. Again highlighting the exploratory drilling is the testing of the deeper sediments. Two Cambro-Ordovician successes were recorded, a small oil producer in Violet Township, Fairfield County, and a gas producer in Canaan Township, Wayne County. A first successful offset to confirm a Cambro-Ordovician gas pool has been completed. Many additional tests by both major and independent operators to continue exploration of these deeper sediments are anticipated in the coming year.
 --Auth.

- 3-3505. Mackey, F.L. DEVELOPMENTS IN OKLAHOMA IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 802-815, 4 figs., 13 tables, June 1961, 11 refs.

Exploratory drilling decreased 8.8% in Oklahoma during 1960. A success of 27.5% was attained. Fifty-one new-field wildcats were discovery wells from a total of 262 new-field wells drilled for 19.4% success. Significant new-field discoveries were

made in the Anadarko and Arkoma basins.

A high exploratory success ratio continues, indicating improved geological and geophysical interpretations. Successful exploratory drilling encouraged additional leasing, resulting in approximately 70% of the state being currently under lease.

Oil production for the year was down slightly compared with 1959. Gas production increased appreciably. Secondary recovery continued to account for a considerable amount of the total oil produced.

Seismic activity decreased 19.5% compared with the previous year.--Auth.

- 3-3506. Deacon, R.J. OFFSHORE OREGON ATTRACTS LEASE OFFER: Oil & Gas Jour., v. 59, no. 16, p. 156-158, 160, 2 maps, Apr. 17, 1961.

A recent application by Shell Oil Co. for Oregon's offshore lands has focused attention on this relatively unexplored section of submerged oil possibilities. This paper gives a brief description of the stratigraphy of the Coos Bay, Newport, and Nehalem embayments and of the Willamette-Astoria basin.--T. C. McLean.

- 3-3507. Lytle, William S. DEVELOPMENTS IN PENNSYLVANIA IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 734-748, 3 figs., 8 tables, June 1961, 41 refs.

During 1960, exploration in Pennsylvania resulted in the discovery of 1 new gas field, 8 new gas pools, and 1 deeper pool. It also extended several gas-producing areas, and established a new producing-depth record in the state. After drilling a dry hole to the Gatesburg formation (Upper Cambrian) in each of its 2 offshore blocks, the New York State Natural Gas Corporation surrendered its acreage. The new producing-depth record was established by the Robert I. Snyder well No. 1 in Somerset County when gas was found in the Oriskany at 8,574 ft. The well had an initial open-flow after fracturing of 1,572 MCF of gas at a rock pressure of 3,293 p.s.i. in 44 hrs.

Deep exploration (Middle Devonian or older) found all of the new pools and the one new field. Of the unsuccessful wildcats, 12 were new-field wildcats and 6 were new-pool wildcats. Three deeper pool tests were unsuccessful as were 10 outposts. One new-field wildcat, 8 new-pool wildcats, 1 deeper-pool test, and 3 outposts were successful. There were 61 development gas wells completed and 21 dry holes. The greatest density of deep drilling occurred in Clearfield County. There were 126 deep wells completed in Pennsylvania in 1960 with a total footage of 851,347 ft. Of the 126 wells, 74 were gas wells and 52 were dry holes.

Secondary-recovery projects in the Bradford field and the development drilling in the gas fields dominated the shallow-sand drilling activity during 1960. No new shallow-sand oil or gas discoveries were made. In all, 745 shallow-sand wells were completed. Of these, 175 were gas wells, 24 were oil wells, 47 were dry holes, 2 were drilled for underground gas storage, and 497 were drilled in connection with secondary-recovery operations. In addition to the 745 wells, 42 shallow-sand wells were deepened. The total footage of the new and deepened wells was 1,578,933 ft.

Oil production increased from 5,760,000 bbls. in 1959 to 5,942,000 bbls. in 1960. Proved oil reserves were estimated at 108,028,000 bbls. on Dec. 31, 1960. Gas production increased from 118,862,000 MCF in 1959 to 119,671,000 MCF in 1960. Gas reserves

were estimated at 1,192,132,000 MCF at the end of the year. Distillate produced in 1960 amounted to 67,000 bbls. The total footage drilled, both shallow and deep, was 2,430,280 ft.--Auth.

3-3508. Montgomery, Hugh Brinton. A GUIDE TO INFORMATION FOR LEASING AND OPERATING OIL AND GAS LANDS OWNED BY THE COMMONWEALTH OF PENNSYLVANIA: 117p., 18 figs. incl. maps, secs., [1960?], 52 refs.

Oil and gas exploration and development is encouraged on nearly 3 million acres of publicly-owned land in Pennsylvania. These lands are under the jurisdiction of 2 separate Commonwealth agencies. The Dept. of Forests and Waters controls approximately 2 million acres of land. The Game Commission holds jurisdiction over 900,000 acres. An additional 570,000 acres of Lake Erie acreage is under the jurisdiction of the Dept. of Forests and Waters.

The primary purpose of this handbook is to encourage the development of oil and gas beneath these lands. However, it is hoped that private lands will also benefit from any new operations which may result from the information made available in this publication.

To accomplish its purpose the handbook provides extensive information on the minerals program of the Dept. of Forests and Waters and guides the user to sources of additional information needed by any newcomer to oil and gas operations in Pennsylvania.--Intro.

The publication is in 2 parts. Pt. 1 contains geological and related information pertaining to oil and gas in Pennsylvania (tools of exploration - publications, maps, logs, etc.; engineering practices; conservation; legal aspects; Commonwealth agencies and oil and gas operations on state lands). Pt. 2 deals with oil and gas leasing and developments on state forest land (history of development; leasing policy; leasing on Lake Erie; leasing for gas storage, seismic surveying policy; potential for development of oil and gas production in Appalachian basin and Pennsylvania state owned acreage). Appendix contains maps and statistics.

3-3509. Milhous, H.C. OIL AND GAS DEVELOPMENTS IN TENNESSEE IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 767-768, map, table, June 1961.

At least 130 test wells were drilled in 1960. Thirteen of these made some oil, 3 were abandoned, and 2 were producing 20 BOPD or more at the end of the year. One small gas well was producing, and 3 non-commercial wells were capped.--Auth.

3-3510. Stanley, Herbert M., Jr., and William C. Eisenhardt. DEVELOPMENTS IN EAST TEXAS IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 861-867, map, 4 tables, June 1961, 2 refs.

More wells were drilled in 1960 than 1959. Four major fields were added to the area. There were 22 new-field discoveries: 5 in the Upper Cretaceous, 9 in the Lower Cretaceous, and 8 in the Jurassic. New-pool discoveries and field extensions numbered 43. Total number of wells increased by 29 from 1959. There were 365 exploratory tests drilled, of which 13.4% were successfully completed.

Geophysical activity totaled 779 crew-weeks, an increase of 78 crew-weeks from 1959, due mainly to

increased Jurassic interest. Core-drill activity totaled 75 crew-weeks, an increase of 22 crew-weeks over the previous year.--Auth.

3-3511. Horak, Ralph L., and others. DEVELOPMENTS IN WEST TEXAS AND SOUTHEASTERN NEW MEXICO IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 825-836, 3 figs., 5 tables, June 1961, 8 refs.

Reappraisal of operations directed toward greater economy and selectivity of wildcat and development programs characterized the industry through a period of reduced drilling and production in the Permian basin. Optimistic forecasts for the future, however, are evident in view of the tempo of seismic and leasing activity.

Two Pecos County wildcats became the most significant gas strikes in many years and have drawn attention to the deep possibilities of the Delaware basin: the Atlantic's Kelly No. 1 indicated multipay gas production from the Devonian, Silurian, and Ordovician Montoya at a depth of 16,680 ft., a record producing depth in Texas; the Mobil Oil Company's Kathleen J. Moore No. 1 was completed for a calculated open-flow potential of 102 MMCFGPD plus 1,500 bbls. of condensate from the Pennsylvanian Bend to become the first Lower Pennsylvanian producer in the Texas part of the Delaware basin.

The heavy concentration of leasing and geophysical activity in the Delaware and Val Verde basins reflects the normal cycle of exploration into the more remote regions.--Auth.

3-3512. Womack, William A., Jr. DEVELOPMENTS IN WEST-CENTRAL TEXAS IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 847-852, map, 6 tables, June 1961.

Total drilling activity decreased 8.3% in 1960. In 1959 a total of 2,561 wells were drilled as compared with 2,140 wells in 1960. Exploratory wells totaled 577, a decrease of 14.4% from the 674 of the previous year. Development drilling during 1960 decreased 9.2% with 1,563 wells as compared with 1,683 wells in 1959.

Total oil production decreased 4.4% from 48,197,523 barrels produced in 1959 to 46,122,658 barrels in 1960. This decrease is due to a decline in exploratory and development drilling and to a decrease in allowable days from 10.25 days in 1959 to 8.66 days in 1960.

Geophysical activity decreased 37.8% with a total of 209 crew-weeks in 1960 as compared with 336 crew-weeks for 1959. Subsurface geological methods were credited with the majority of new discoveries.--Auth.

3-3513. Rogers, R.G., and J.D. Tinsley. DEVELOPMENTS IN TEXAS AND OKLAHOMA PANHANDLES IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 816-824, map, 4 tables, June 1961, 3 refs.

Exploratory activity in the Panhandle district during 1960 was down 36%, and development drilling was off 20%. Exploratory success ratios were 3% higher than the previous year, indicating that drilling prospects are being selected with more care. The Anadarko basin, along with the shallow "Redbed" and deeper Pennsylvanian drilling in the Panhandle-Hugoton fields, had the majority of the activity for

1960. Both the Dalhart and Palo Duro basins were slow.

In 1961, activity will be similar to 1960, with shallow and deeper plays in the Panhandle-Hugoton fields showing a marked increase.--Auth.

3-3514. Henry, Gary E. DEVELOPMENTS IN NORTH TEXAS IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 837-846, map, 5 tables, June 1961.

In 1960, 3,538 wildcat and development wells were drilled in the 15-county area composing N. Texas. One hundred fourteen exploratory tests were successfully completed; these included the discovery of 62 new fields, 50 new pools, and 2 extension wells. Most of the new production is from the Pennsylvanian Strawn and Atoka series. Drilling and production maintained a steady pace despite the sharp drop in the number of producing days. The most significant discovery was in the Conley field in the Hardeman basin where 3 new pays were indicated.--Auth.

3-3515. Reiss, Bernard W., and others. DEVELOPMENTS IN SOUTH TEXAS IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 853-860, map, 4 tables, June 1961.

S. Texas drilling declined 9% in 1960 from the 1959 level. No new major fields are apparent at the current stage of development. Although exploratory drilling increased 2%, the success ratio was 1.1% under that of 1959. Development drilling was shown 8.8%. The 60 gas discoveries were slightly more than twice the 28 oil discoveries in 1960; the ratio in the past 3 years has been closer to 1:1. Oil production decreased by 5% while gas production was up 7%. Wildcatting along the deep Edwards and deep Wilcox trends continues to increase. Geophysical activity dropped sharply, about 30% below 1959's total.--Auth.

3-3516. Tague, Glenn C., and Curtis W. Burgess, Jr. DEVELOPMENTS IN UPPER GULF COAST OF TEXAS IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 868-878, map, 4 tables, June 1961, 6 refs.

This paper is devoted to exploration and development activity for 1960 in the 29 counties of Texas Railroad Commission District 3 and in the adjoining continental shelf area.

There was a slight increase of 16 wells in the total drilling for 1960 as compared with total wells drilled in 1959. There were 6 fewer exploratory wildcats and 22 more development wells drilled in 1960 than in 1959. In 1960 there were 34 new oil (15) and gas (19) fields discovered in the district, chiefly along the deep Frio, Wilcox, and Yegua trends.

Crude oil production decreased nearly 11 million bbls. in 1960. The drop in production was partly due to restrictions on production. Oil production in Texas in 1960 declined to an average of 8.66 days per month, compared with an average of 9.25 days in 1959. Gas and condensate production increased in 1960 over 1959.

Offshore exploratory wildcat wells drilled totaled 8, an increase of 2 wells from the 6 drilled during 1959. It is expected that exploratory drilling during 1961 will be most active along the deep Frio, Yegua, and Wilcox trends.--Auth.

3-3517. Thomas, A. Ralph, and Graham S. Campbell. OIL AND GAS DEVELOPMENTS IN UTAH AND

NEVADA IN 1960: Am Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 932-937, 2 maps, 6 tables, June 1961.

Exploratory drilling in Utah increased during 1960. Number of wells drilled was up 23% and footage drilled increased 30.4%. Success ratio for exploratory wells was 24.8%, up 12.6% from the previous year. Probably the most significant exploratory activity in Utah during 1960 was the completion of the Pure's Northwest Lisbon No. 1 Devonian oil discovery which opened a new pay zone for the eastern Paradox basin and revived interest in the Mississippian. Geophysical activity showed a slight decrease for the second consecutive year. Federal lands under lease in Utah increased more than 500,000 acres during 1960. New leasing in Utah was within the hinge-line zone between the Great basin and the Colorado plateaus. Nevada experienced a revival of large-scale leasing during 1960, particularly in White Pine County.

With the major oil fields nearing full development, development drilling accounted for only 117 wells, a decline of 43%. Success ratio for development drilling was 83.6%, down 6.4% from the 1959 record year. Production was down 5.9%, due to the conservation measures passed by the Utah Oil and Gas Conservation Commission. Exploratory drilling in Nevada was negligible as only 4 shallow, unsuccessful tests were completed during the year. The outlook for 1961 is for increased drilling activity in the Uinta basin, eastern Paradox basin, and the Book Cliffs area of Utah.--Auth.

3-3518. Tucker, R.C. OIL AND GAS DEVELOPMENTS IN WEST VIRGINIA IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 757-760, table, June 1961.

The total number of wells drilled in West Virginia in 1960, reported to Feb. 22, 1961, was 1,216, an increase of 311, or 34%. Permits to drill or deepen issued by the Oil and Gas Division of the West Virginia Dept. of Mines totaled 1,349, an increase of 342, or 34%. Seventy-nine permits to drill were cancelled during the year.

Abandoned during the year were 200 gas wells and 212 oil wells; a total of 412 wells. These abandonments are all wells drilled before permits were required (May 1929). No information about the exact number of abandonments of wells drilled since May 1929, is available as these wells are abandoned under original drilling permit numbers. Wells completed were: gas, 794; oil 49; oil and gas wells, 182; storage, water-injection, brine, rock salt, and pressure wells, 49; dry holes 142; total 1,216. Compared with 1959, gas wells increased 203, or 34%; oil wells increased 12, or 32%; oil and gas wells increased 87, or 91%; storage and other wells decreased 10, or 20%, with some being drilled for gas storage; dry holes increased 19, or 15%, the percentage of dry holes to total completions being slightly over 11%. Depth of wells ranged from 370 to 13,121 ft. compared with 206 to 8,635 ft. in 1959. Total footage drilled was 2,908,817 ft., an increase of 687,343 ft., or 29% over 1959 (2,341,474 ft.). The average depth of wells (2,392 ft.) decreased 173 ft. under the 1959 average (2,565 ft.), or 7 1/2%. The total initial daily open flow of the gas wells was 983,422 MCF, an increase of 295,301 MCF, or 43% over the 1959 total (688,121 MCF). The size of the gas wells ranged from 10 to 28,400 MCF, compared with 4 to 39,680 MCF in 1959. The total daily initial oil was 4,117 1/2 bbls., an increase of 709 bbls. over 1959 (3,408 1/2 bbls.) or

28%. The size of the oil wells ranged from 1/2 to 300 bbls., compared with 1/2 to 220 bbls. in 1959. The number of wells drilling or unreported if completed at the end of the year was 529, 82 more than in 1959, or an increase of 18%.

Since we receive drilling and scout reports from several major companies, the status of practically every drilling well was known, and no letters were sent to the operators regarding their uncompleted wells. It is believed the total completions will be greater than herein reported as also the production since many wells were reported as testing after fracture. The total initial gas production after fracture is generally several times the production before fracture. Several hundred wells were fractured during the year. The West Virginia University collects information concerning fracturing of wells and issues an annual report showing details for each of the wells fractured.

The average size of gas wells was 1,111 MCF, compared with 1,003 MCF in 1959, an increase of 108 MCF or 11%. In calculating this average the number of gas wells was increased by one-half of the number of oil and gas wells (91) or 885 wells. The average size of the oil wells was 29 bbls. compared with 40 bbls. in 1959, a decrease of 11 bbls., or 27 1/2%. One-half the oil and gas wells (19) was added to the 49 oil wells in calculating this average.

Preliminary estimates of production for 1960: gas, 207,000,000 MCF, compared with 205,000,000 MCF in 1959; an increase of 2,000,000 MCF or approximately 1%; oil, 2,300,000 bbls., an increase of 116,000 bbls. over the 1959 estimate (2,184,000 bbls.) or 5 1/3%. The estimated number of producing wells at the end of 1960: gas, 16,485; oil, 12,669. The table of operations gives statistics by counties.--Auth.

3-3519. Masterson, James A. DEVELOPMENTS IN WYOMING AND IDAHO IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 6, p. 926-931, map, 4 tables, June 1961, 5 refs.

Wyoming maintained approximately the same level of exploratory activity during 1960 as the previous year. Three hundred new-field wildcats produced 14 new oil fields and 7 gas discoveries.

The search for Cretaceous stratigraphic traps and Pennsylvanian oil highlighted activity in the Powder River basin. In the Green River basin, field development of Patrick Draw turned the 1959 discovery into one of the largest oil fields in Wyoming, spurring the search for Tertiary and Upper Cretaceous discoveries in the area. The Wind River basin also received considerable emphasis in the same stratigraphic horizons while other producing areas remained relatively dormant.

Exploratory activity for the coming months will follow the same basic trend as the past year. Continued success in delineating stratigraphic possibilities is anticipated as more and more control becomes available. One wildcat, a failure, was drilled in Idaho during 1960.--Auth.

3-3520. Mina Uhink, Federico. PETROLEUM DEVELOPMENTS IN MEXICO IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p. 1029-1044, 8 figs., 6 tables, July 1961.

A new mark was set by Petróleos Mexicanos with the drilling of 762 wells during 1960, this being a considerable increase over the 441 wells drilled during the preceding year. An all-time high for Mexico a-

mounted to 5,273,314 ft., drilled with an average of 6,920 ft. per well.

Of the total number of wells drilled, 176 wells were classified as exploratory holes, of which 87 were new-field wildcats resulting in the discovery of 15 new oil and (or) gas fields. Other exploratory holes were classified as follows: 21 new-pool wildcats, 11 deeper-pool wildcats, 8 shallower-pool wildcats, and 49 extensions, totaling 89 exploratory wells of which 61 were completed as producers. Of the total 762 wells drilled, 582 were completed as producers.

The new fields discovered were located as follows: 2 in the Eocene and 2 in the Oligocene trends in north-eastern Mexico; 5 in Cretaceous formations in the Tampico embayment; 5 in Miocene sands in the Isthmus and Tabasco region, and one outstanding discovery in Cretaceous limestones in the foothills of the Sierra Madre, S. of the Saline basin in the Isthmus region.

Surface geological and geophysical exploration activities were concentrated in the coastal plain of the Gulf of Mexico although some exploration was also carried on in the Cretaceous trends in northeastern Mexico in the state of Coahuila; seismological exploration was continued in the Sebastián Vizcaíno embayment in Baja California, and systematic gravity-meter surveys were made in N.-central Chihuahua and in eastern Quintana Roo.

Crude oil and distillate production in 1960 was 108,771,585 bbls., an increase of 9.7% over the previous year. Total gas production was 341,266,000 MCF with an increase of 9.6% over 1959.--Auth.

3-3521. López Ramos, Ernesto. ORIGEN DEL PETROLEO EN RELACION A LAS CUENCAS DE DEPOSITO [Origin of Petroleum in Relation to Basins of Deposition]: Asoc. Mexicana Geólogos Petroleros, Bol., v. 11, no. 3/4, p. 155-167, map, 2 secs., March-Apr. 1959, 4 refs.; text in Spanish.

A brief attempt is made to describe the pattern of oil migration in the main oil-producing areas of Mexico, with special reference to possible source rocks. Short descriptions are included of the reservoir characteristics and nature of fluids found in the fields of the Burgos basin, the Ebano-Altamira district, the Golden Lane (Faja de Oro), the New Golden Lane, the region E. of the Golden Lane, the Poza Rica district, the Veracruz basin, and in the San Andrés field.

Production from the majority of reservoirs is due to a type of water drive, although some of gas-expansion type are also known, especially in the fields of Tabasco and northeastern Mexico. The Poza Rica and San Andrés fields, as well as the New Golden Lane, are considered to be of mixed type.

The 2 large structural elements which contained source rocks are the Mexican geosyncline and the Gulf geosyncline. Both are oriented from NW. to SE. and are separated by the Tamaulipas platform and its continuation to the NW., the Burro Picacho platform. Both geosynclines were affected tectonically which caused the hydrocarbons formed in them to migrate to higher parts adjacent to the Tamaulipas platform, where they accumulated in Jurassic and Cretaceous rocks and, eventually, in the sands of northeastern Mexico and the sandstones of Tampico (both of Tertiary age).--A.H. Gutstadt.

3-3522. Clark, E. W., and others. PETROLEUM DEVELOPMENTS IN SOUTH AMERICA AND CARIBBEAN AREA IN 1960: Am. Assoc. Petroleum Geol-

ogists, Bull., v. 45, no. 7, p. 1045-1089, 19 figs., 18 tables, July 1961, refs.

Exploration activities continued at a high level in Argentina and Brazil, but declined practically to a standstill in Venezuela. South American production of crude averaged almost 3,500,000 b./d. in 1960, and was 5% higher than in 1959; most of the increase came from Venezuela, Argentina, and Brazil. The government of Venezuela set up an agency to operate as a national oil company, thus increasing to 8 the number of governments in the Western Hemisphere participating directly in petroleum exploration and production operations by this means.--Auth.

3-3523. King, Robert E. PETROLEUM EXPLORATION AND PRODUCTION IN EUROPE IN 1960: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 7, p. 1090-1142, 20 figs., 13 tables, July 1961, refs.

Petroleum production in Europe outside the Soviet zone increased 11.3% in 1960 over 1959, to a rate of 286,000 b./d. The greatest rate of increase, 65.2%, was in Yugoslavia, where 2 large fields found in previous years were put on production. There were also substantial increases in France and Italy, and the production decline of the previous year in Austria was arrested. In Austria oil was found for the first time in the Mesozoic floor of the Vienna basin in the Aderklaa field, and gas was found in the Jurassic in the Zwerndorf field. Natural gas production in Austria increased 30% with the completion of new distribution facilities. In France natural gas production increased 226% with the completion of development of the deep Lacq reservoir. A new drilling depth record for France of 17,585 ft. was made in the southern Aquitaine basin. In Germany exploratory drilling continued to decline, but the average depth of wildcats increased due to the greater number of deep tests drilled to the Permian and older formations. There were 9 oil and 3 gas discoveries, and an important new-pool discovery on an older producing structure. Oil was found for the first time in the Mesozoic floor of the Molasse basin near the lake of Constance in SW. Germany, giving impetus to additional exploratory work in adjacent parts of both Germany and Switzerland. A new depth record for Germany of 15,836 ft. was made. In Italy, offshore drilling commenced in the Adriatic Sea, on trend with the Po basin gas fields, and an important discovery of gas was made at Ravenna mare. A gas-condensate discovery was made in northeastern Sicily. In The Netherlands, production in the western part of the country exceeded for the first time that from the Schoonebeek field in the E. Additional exploratory drilling for gas in the northeastern Netherlands resulted in the discovery of what appears to be a large gas reserve in Lower Permian continental sandstones. An important discovery was reported near Novska in the Drava valley, Yugoslavia. There was active but so far unsuccessful exploratory drilling in Switzerland, Spain, and European Turkey, but reduced activity in Portugal and Denmark. Exploration started for the first time in Belgium, Eire, and Spitsbergen, and there was increased activity in Greece, with a resumption of drilling.--Auth.

3-3524. Kurtev, P.I. THE PHYSICAL PROPERTIES OF THE PRODUCING CARBONATE FORMATIONS OF NORTHWESTERN BULGARIA: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 2-B, p. 134-138, 4 figs., 1959, pub. 1961, 3 refs.

The paper briefly mentions the results of various laboratory experiments carried out on dolomites, dolomitic limestones, and limestones, mainly devoid of cavities, in order to determine whether electrical logging methods could be used for studying the reservoir properties and oil saturation of these rocks. Petroleum was extracted from the samples and salt water washed away prior to measurements of permeability, porosity, electrical resistivity, diffusion-absorption activity and electrochemical activity. These determinations were carried out on samples saturated with a specified salt solution. The method of measuring the electrical resistivity is also described. A relationship appeared to exist between porosity and permeability for the dolomites, but not for the limestones. A relationship is also observed between relative electrical resistivity and porosity. The effect of cavities on the character of this relationship is studied with the aid of curves and of Maxwell's formula for the determination of the electrical resistivity of an aggregate. It is found that a change in the ratio cavities intergranular pores affects the relation between resistivity and porosity. A relationship was also found between the ratio of resistivity of the rock in the oil- and water-saturated condition and the coefficient of oil saturation. Finally dolomites showed a larger diffusion-absorption activity and a much larger induced electrochemical activity than limestones and dolomitic limestones.--C. Voûte.

3-3525. Mirchink, M.F. ROLE OF THE DOCTRINE OF I.M. GUBKIN IN THE DEVELOPMENT OF PETROLEUM GEOLOGY IN THE OIL AND GAS PRODUCING INDUSTRY OF THE USSR: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 4-A, p. 222-230, 1959, pub. 1961.

A summary of the views expressed by I. M. Gubkin on the origin of oil and gas in the time of their first migration and on the formation of secondary accumulations. Opponent ideas are also mentioned but are stated to be detrimental to successful oil exploitation, especially in platform areas. The origin of oil and gas is due to organic material disseminated throughout sediments of a mainly clayey and shaly nature. The first mainly lateral migration of oil from the source rocks into associated reservoir rocks is thought to have begun immediately after deposition of the sediments and during the early stages of diagenesis. Great importance is attached to tectonic factors for the secondary transfer of oil and gas into the higher zones of reservoir beds. Both forms of migration, lateral and vertical, are possible in both geosynclinal and platform gas-oil areas. Finally mention is made of the activities of Gubkin in discovering stratigraphic traps, in giving simple interpretations of the tectogenesis of the greater Caucasus and other alpine mountain belts, in promoting research drilling in various areas of the Russian platform, and in stimulating scientific and efficient reservoir engineering of exploited oil pools.--C. Voûte.

3-3526. Trofimuk, A.A. DISCOVERY OF THE URAL-VOLGA OIL DISTRICT - A SCIENTIFIC ACHIEVEMENT OF I.M. GUBKIN: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 4-A, p. 215-221, 1959, pub. 1961.

The history of the exploration of the Ural-Volga region is related for the period 1918, when the work started, to 1940. During this span of time several important oil fields were discovered and various

horizons of the Devonian, the Carboniferous, and the Permian were found to be productive. These results were based largely on regional studies of stratigraphy, facies, and structures. Emphasis is laid on the need to continue the exploration of structural traps.--C. Voûte.

3-3527. Kotelnikov, V.M. PROSPECTS FOR OIL AND GAS IN THE DEVONIAN SEDIMENTS IN THE TERSIN DEPRESSION AND THE CONDITIONS OF FORMATION OF OIL DEPOSITS IN THE KLENOVKA UPLIFT: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 4-B, p. 249-254, sec., 1959, pub. 1961, 3 refs.

The history of the main structures of the Tersin depression in the Stalingrad area is traced. Until the end of the Carboniferous, the sedimentary beds had a monoclinical attitude. A first phase of formation of uplifts followed, which were in part subjected to erosion during the Middle Jurassic transgression. Subsidence during the Jurassic and the Cretaceous was not regular. A second phase of tectonic movements occurred probably at the end of the Cretaceous, during which some structural uplifts showed further rises, while others subsided. Migration and accumulation of oil and gas is thought to have taken place in several stages dependent upon the time of formation of the various uplifts and upon their relative elevation. In this way it is explained why certain Devonian levels show favorable prospects in some of the structural uplifts only, and that the possibility of finding commercial quantities of oil in the Carboniferous sediments is less great.--C. Voûte.

3-3528. Glushko, V.V., and V.T. Sklyar. OIL IN THE OUTER ZONE OF THE CIS-CARPATHIAN DOWN-WARP: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 4-B, p. 259-262, map, 3 tables, 1959, pub. 1961.

Some physico-chemical data are given on the oil of 2 fields recently discovered in the outer zone of the fore-mountain downwarp of the E. Carpathians. They are characterized by a very high specific gravity, high tar and asphalt content and high S content, contrasting sharply with the oil from the Carpathian oil fields situated farther to the SW. The source rocks of the Carpathian oils are considered to be bituminous shales belonging to the Oligocene, whereas the sediments from which the oil of the outer zone apparently developed are much older, probably of a lower Paleozoic age.--C. Voûte.

3-3529. Lvov, M.S. MAIN TASKS OF GEOLOGICAL EXPLORATION FOR OIL AND GAS IN THE WESTERN PART OF CENTRAL ASIA: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 3-B, p. 205-208, 1959, pub. 1960.

Report of a meeting held in Dec. 1958 concerning the achievements in the field of oil and gas exploration in Turkmenistan, W. Uzbekistan and W. Kazakhstan. The papers presented at the meeting are listed by name. Recommendations have been made concerning an increased exploration for oil and gas, and the principal areas are indicated where new or augmented efforts have to be made.--C. Voûte.

3-3530. Hedberg, Hollis D. PETROLEUM DEVELOPMENTS IN AFRICA IN 1960: *Am. Assoc. Petroleum Geologists, Bull.*, v. 45, no. 7, p. 1143-

1185, 13 figs., July 1961, refs.

Petroleum production in Africa in 1960 attained a new all-time high of 99,672,705 bbls., representing an increase of 139% over the previous year. This gain was due largely to a 7-fold increase in production from Sahara. Producing countries in order of 1960 production are: Algeria (including Sahara), Egypt, Nigeria, Gabon, Morocco and Angola; and 22 newcomers: Congo Republic and Senegal.

In 1960, 227 exploratory wells were completed in Africa, of which 25% were successful. Of new discoveries 22 were made in Libya, 17 in Algeria (including Sahara), 12 in Nigeria, 4 in Gabon, and 1 in Egypt. Exploratory drilling was carried out this year without success in Angola, Congo Republic, Gambia, Ivory Coast, Kenya, Madagascar, Morocco, Portuguese Guinea, Senegal, Somali Republic, Spanish Sahara, and Union of South Africa. During the year, 260 development wells were completed of which 83% were productive. The development drilling was largely in Algeria (including Sahara), Egypt, Libya, and Gabon. A total of 3,624,272 ft. of hole was drilled in 1960, an increase of 22% over 1959, and at the end of the year 116 rigs were in operation.

Geological-geophysical exploratory work was more extensive in Libya and Algeria (including Sahara). Party-months for the whole of Africa were as follows: surface geology - 623, seismograph - 1,155, gravimetry - 162, ground magnetometer - 26, air magnetometer - 3. New concession activity took place in Spanish Sahara, Algeria (including Sahara), Libya, Mauritania, and Niger.--Auth.

3-3531. Hotchkiss, Henry. PETROLEUM DEVELOPMENTS IN MIDDLE EAST AND ADJACENT COUNTRIES IN 1960: *Am. Assoc. Petroleum Geologists, Bull.*, v. 45, no. 7, p. 1186-1223, 20 figs., 31 tables, July 1961.

Petroleum production in the Middle East countries in 1960 totalled 1,924,469,000 bbls., an average of 5,258,112 b./d. This figure shows an increase over 1959 in which year total production was 1,678,553,000 bbls. - an average of 4,598,606 b./d.

Production in Pakistan in 1960 totalled 2,639,000 bbls., an average of 7,210 b./d. This compares with a total of 2,335,000 bbls. in 1959 - an average of 6,398 b./d.

Production in India during 1960 is estimated to have totalled 3,367,000 bbls., an average of 9,200 b./d. This is slightly below the estimated total production of 3,467,000 bbls. in 1959 - an average of 9,500 b./d.

Decreases in exploration acreage held were noted in Turkey, Pakistan, India, and the Hadhramaut. The license position remained substantially unchanged in most other countries.

Important discoveries were made during 1960 in the Kuwait-Saudi Arabia offshore area and in the Iranian offshore area. Other discoveries were made in Turkey at Bulgurdag, in India at Ankleshwar, in Israel at Negba, and in the Qatar offshore area. An unassessed discovery is reported from Afghanistan.

In general, the exploratory effort remained at about the 1959 level throughout most of the area under review.--Auth.

3-3532. Kaufmann, Godfrey F. PETROLEUM DEVELOPMENTS IN FAR EAST DURING 1960: *Am. Assoc. Petroleum Geologists, Bull.*, v. 45, no. 7, p. 1224-1243, 6 figs., 12 tables, July 1961.

The governments of 2 more countries of the Far East, Indonesia and Burma, have taken steps in 1960 toward nationalization of petroleum production. The governments of Japan and Formosa have virtual monopolies on oil production in these countries, and of course the U. S. S. R. and Communist China have absolute control over their petroleum industries. Japan and probably Communist China are the only areas in the Far East where new production has been obtained in appreciable amount although intensive exploration programs have been carried on in nearly all areas of the Far East possibly favorable for oil or gas accumulation. Exploration drilling has been increased in the Philippines with some encouraging

results, but as yet commercial quantities of oil or gas have not been discovered. The total production of the Far East during 1960 was 233,439,089 bbls. of oil while during 1959, 221,652,407 bbls. were produced, a gain in 1960 of nearly 12 million bbls.--Auth.

3-3533. West Virginia, Dept. of Mines. ANNUAL REPORT... 1960: 243 p., illus., tables, Charleston, 1961.

This report contains directory and detailed information on production in underground, surface, auger, and quarry coal mines in 1960. It also contains the annual report of the Oil and Gas Division.--A. C. San-gree.

14. ENGINEERING GEOLOGY

See also: Geomorphology 3-3234; Mineralogy 3-3383.

3-3534. Legget, Robert F. GEOTECHNIQUE: NEW WORD - OLD SCIENCE: Geol. Assoc. Canada, Proc., v. 12, p. 13-19, Dec. 1960, 12 refs.; also pub. as: Natl. Research Council Canada, Div. Building Research, Tech. Paper no. 120 (NRC 6174).

In contrast with the general trend toward specialization in science, the necessary integration of geological, pedological, and engineering studies of soil for the proper solution of soil problems is to be welcomed. The word Geotechnique, first apparently used in Sweden, is to be welcomed as a description of integrated soil study. The work of Canadian workers in the several disciplines mentioned can be traced back for well over a century, thus giving warrant for the use in Canada of this descriptive term, particularly in view of the bilingual character of the country.--Auth.

3-3535. DRILLING AND BLASTING SYMPOSIUM. Jointly Sponsored by the Department of Mining at The Colorado School of Mines, The University of Minnesota, The Pennsylvania State University: Colorado School Mines, Quart., v. 56, no. 1, 338 p., illus., diags., graphs, tables, Jan. 1961, refs.

Papers and discussions are presented from the Tenth Annual Drilling and Blasting Symposium held at the Colorado School of Mines, Golden, Oct. 16-19, 1960. Papers are listed below:

Drag Bits and Machines, by R. H. Goodrich.
Laboratory Rotary Rock Bits, by J. D. Medlock.
Efforts to Develop Improved Oil Well Drilling Methods, by L. W. Ledgerwood, Jr.

Rotary Percussion Air Hammer Drilling, by Walter E. Liljestrand.

Higher Air Pressures for Bottom-Hole Percussion Drills, by E. P. Pfeider and W. D. Lacabanne.
The "Galis" Rotary Percussion Roof Drilling Machine, by Harley G. Pyles.

Drilling and Drill Steel Progress at the Idarado Mining Company, by John C. Keenan.

Recent Developments and Trends in Production Blast-Hole Drilling on the Mesabi Range, by Donald K. Nelson.

Drilling Beneath the Ocean, by Willard Bascom.
The Effects of Coupling on Explosive Performance, by Thomas C. Atchison.

Application of the Livingston Theory, by Alan Bauer.
Particle Characteristics of Ammonium Nitrate and Blasting Agent Performance, by George B. Clark and others.

Ammonium Nitrate Slurry Blasting Agents, by Melvin

A. Cook.

Fracturing of Rock Salt by a Contained High Explosive, by Nicholas M. Short.

New Drilling and Blasting Techniques for Deeper Drift Rounds, by Karl-Fredrick Lautmann.

Theory and Practice of Inclined Drilling for Surface Mining, by Boris J. Kochanowsky.

Drill Pattern and Initiation-Timing Relationships for Multiple-Hole Blasting, by Richard L. Ash.

Drilling and Blasting Symposium Summary, by John J. Reed and John S. Rinehart.

3-3536. SYMPOSIUM ON ROCK MECHANICS. 4TH, UNIVERSITY PARK, PENNSYLVANIA, MARCH 30-APRIL 1, 1961: [54]p., illus., diags., University Park, Pennsylvania State University, 1961.

The symposium contains the following papers and abstracts:

General Survey of Underground Strata Movements in Mines, by Bertrand Schwartz.

Creep Measurements in Salt Mines (Abstract), by T. D. Reynolds and E. F. Gloyne.

Michigan Mines Subsidence Case Histories - Subsidence Report No. 9 (Summary and Conclusions), by Burton H. Boyum.

Subsidence Due to Mining - A Case History, by Don U. Deere.

Theoretical Aspects of Rock Behavior Under Stress, by Eugene F. Poncelet.

Transition From Elastic to Plastic States of Rocks Under Triaxial Compression (Abstract?), by Shosei Serata.

The Effect of Strain Rate on the Behavior of Rocks Subjected to Triaxial Compression and Temperature (Abstract), by S. Serdengecti and G. D. Boozier.

Dependence of Fracture Strength of Rocks on Grain Size, by W. F. Brace.

Laboratory Determination of Some Physical Properties of Rock (Abstract), by C. Fairhurst.

Propagation Velocity of Longitudinal Waves in Rocks: Effect of State of Stress, Stress Level of Wave, Water Content, Porosity, Temperature, Stratification, and Texture (Abstract?), by John S. Rinehart and others.

Brittle Fracture of Small Short Rock Beams Under Central Transverse Impact Loading (Abstract), by George B. Clark and R. D. Caudle.

The Hugoniot Equation of State of Rocks (Summary), by David B. Lombard.

Stress Waves Resulting From Rock Failure (Abstract), by E. de St. Q. Isaacson.

Rock Breakage in Quarry Blasting (Abstract), by

Thomas C. Atchison and others. Methods for Determining Rock Pressure (Abstract), by Louis A. Panek.
 A Laboratory Investigation of a High Modulus Borehole Plug Gauge for the Measurement of Rock Stress, by A.H. Wilson.
 The Natural Arch, the Fracture Pattern, and the Sequence of Fracture in Massive Rocks Surrounding an Underground Opening (Abstract), by Clifton W. Livingston.
 Rib Control of Bedded Roof Stresses (Abstract), by Lawrence Adler.
 Flat Jacks Pre-Load Massive Mine Supports (Abstract), by John J. Reed.
 Hypothesis for the Mechanism of Rock Failure Under Impact (Abstract), by Madan M. Singh.
 Rate of Loading Effects in Chisel Impact (Abstract), by F.C. Appl and W.S. Gatley.
 Photographic Study of Rock Failure in Drag Bit Drilling (Abstract), by Carl Gatlin and Kenneth E. Gray.

3-3537. Swenson, E.G., and J.E. Gillot. CHARACTERISTICS OF KINGSTON CARBONATE ROCK REACTION: Natl. Research Council, Highway Research Board, Bull. 275 (Natl. Acad. Sci.-Natl. Research Council, Pub. 813), p. 18-31, 10 figs. incl. illus., graphs, 3 tables, 1960, 12 refs.

The argillaceous dolomitic limestone from the Ordovician Black River formation at Kingston, Ontario, reacts in concrete causing excessive expansion and cracking when used as coarse aggregate. A laboratory study of the Kingston carbonate rock reaction, distressed concrete, and the carbonate rock indicate that marked differences and similarities between the reaction and the characteristics of the well known alkali-aggregate reaction associated with the use of certain siliceous aggregates in concrete.

The points of similarity were: 1) the specific influence of alkali content, whether it derives from the cement or is added; 2) the more aggressive influence of the sodium than the potassium hydroxide; 3) the influence of temperature, with evidence of an optimum; 4) the direct influence of moisture; and 5) the abnormal expansion of concrete, followed by map-cracking where moisture conditions vary at 2 surfaces.

Characteristics that show some limited degree of similarity were: 1) rate and degree of expansion were apparently higher in this case; 2) decrease in expansion with decrease in particle size of aggregate, apparently due to break-up at planes of weakness as well as to increase in surface area for a fixed amount of alkali; 3) rim formation present but different in appearance from the alkali-silica type; 4) microscopic evidence of fracturing of paste and aggregate but difference in appearance of affected areas.

Distinguishing features were: 1) absence of significant quantities of gel; pore volume was extremely small, and amount of silica very small, hence it is not likely that failure to detect gel is due to its distribution throughout the pores; 2) absence of minerals or rock types known to react deleteriously with cement alkali; 3) failure of alkali-silica reaction inhibitors to control this alkali-carbonate rock reaction; 4) increase in water-cement ratio apparently does not increase rate of reaction; 5) uncracked parts of the affected concrete appear to remain intact, even after many years.

The Kingston carbonate reaction is not detectable by the standard ASTM tests (Mortar Bar test; Quick Chemical Test, Conrow Test). It may be detected

by the Scholer Test or by expansion of 3 x 4 x 16 in. and 3 x 3 x 10 in. concrete prisms made of the suspected aggregate and high alkali cement conditioned at 73°F in 100% humidity in periods from 3 weeks to several months. It may also be detected by measuring expansions of the rock in alkaline solution.

As a tentative conclusion carbonate rocks composed of near equal proportions by weight of dolomite and calcite may be regarded as suspect, and it seems possible that a connection exists between the expansive reactivity and dedolomitization reaction (replacement of dolomite by calcite and brucite).-- J. Lemish.

3-3538. Bisque, Ramon E., and John Lemish. EFFECT OF ILLITIC CLAY ON CHEMICAL STABILITY OF CARBONATE AGGREGATES: Natl. Research Council, Highway Research Board, Bull. 275 (Natl. Acad. Sci.-Natl. Research Council, Pub. 813), p. 32-38, 4 tables, 1960, 11 refs.

This report is related to 2 previous publications by the authors. The reports are a result of studies aimed at defining the type of chemical reactivity which results in the growth of reaction shells in certain carbonate aggregates. Studies to date have supported the postulation that the clay fraction of these rocks makes them susceptible to this type of reactivity, due to the fact that the clay particles serve to stabilize soluble S. (the exact ionic species involved are not known; that is, SiO_4^{-4} , $\text{Si}_2\text{O}_7^{-6}$, etc.) and upset the equilibria which would normally exist in concrete. The net effect is the formation of a Si-rich shell around the periphery of the aggregate particle and concomitant removal of S. from the cement paste.

The present report summarizes additional experimental demonstrations of the fact that the illitic clay fraction of these carbonate aggregates serves to react with Si in a manner which is distinct from the processes involved in the "alkali-aggregate reaction." Flame photometric analyses of aggregate particles for Na and K were made before and after shell growth, demonstrating that the soda and potash content of the peripheral zone was not increased.

Reaction shells were caused to form in concrete bars under controlled conditions. Similar bars made with acceptable carbonate aggregate were subjected to the same conditions for comparison. Length changes were measured, and compressive strength tests were run on both "treated" and "untreated" bars. It was shown that the growth of prominent reaction shells throughout the concrete was not accompanied by excessive expansion of the bars. Preliminary tests indicate that the increase in compressive strength which normally accompanies hydration is definitely diminished when shell growth occurs in the concrete.-- Auth.

3-3539. Hershey, H. Garland, and others. HIGHWAY CONSTRUCTION MATERIALS FROM THE CONSOLIDATED ROCKS OF SOUTHWESTERN IOWA: Iowa, Highway Research Board, Bull. no. 15, 151 p., 28 figs. incl. maps, secs., 1960, 60 refs.

Near-surface supplies of stone available for highway construction purposes are scarce in southwestern Iowa. This report records the results of a regional geological study, made with the primary objective of finding new and significant deposits. The Nebraskan and Kansan tills and related sediments and the Dakota sandstone, are described very briefly, as none of them yield much material for highway aggregate in

this area. The stratigraphy and structure of Pennsylvanian rocks, which include the Des Moines, Missouri, and Virgil series, are described in detail. Pre-Pennsylvanian rocks, which furnish much road material in other parts of the state, are too deeply buried here to be of economic interest. Geology of each of the 11 counties included within the area of the report is described separately. Emphasis is on local stratigraphy, but present and potential sources of rock for quarrying are clearly described as to location and depth beneath the surface.--E. B. Eckel.

3-3540. Gibbs, H. J., and William Y. Holland. PETROGRAPHIC AND ENGINEERING PROPERTIES OF LOESS: U.S. Bur. Reclamation, Eng. Monographs, no. 28, 37 p., 24 figs., Nov. 1960, 9 refs.

The engineering properties of loess, mostly from Nebraska and Kansas, have been studied extensively by the U.S. Bureau of Reclamation. The main source of the wind-deposited loess probably was from outwash plains of glaciers. Loess principally is uniformly sorted silt, clay, and fine sand particles of quartz and feldspar, in a loose arrangement with numerous voids and rootlike channels.

The physical properties of loess are similar over wide areas. Mechanical analyses of 148 sample show that 76% were silty loess, 18% were clayey loess, and 6% were sandy loess. The specific gravity ranged from 2.57 to 2.69. The plasticity indices were predominantly between 5 and 12 and the liquid limits between 25 and 35%. The vertical permeability ranges from 0.1 to 5 ft. per year when above 100 lbs. per cu. ft. dry density and is between 200 and 900 ft. per year at about 80 lbs. per cu. ft. dry density. Initial density seems to control settlement which ranges from 5 to 30%. Shear resistance is variable. Plate load tests indicated that computed values of settlement checked the actual measured settlements fairly well for large size plates but were less accurate for smaller plates. Ponding may be desirable in some cases to develop the weakest condition prior to construction. The method of emplacement and type of pile used in loess should be governed by density, thickness, and future expectable moisture content.--R. Van Horn.

3-3541. Poland, Joseph F., and Jack H. Green. SUBSIDENCE IN THE SANTA CLARA VALLEY, CALIFORNIA - A PROGRESS REPORT: U.S. Geol. Survey, Repts., Open-File Ser., 16 p., 12 figs. incl. 4 maps, 2 secs., 3 profiles, 1960, 6 refs.

Subsidence of the land surface in the Santa Clara Valley, Santa Clara County, has been observed since 1933. A network covering the area of subsidence was first leveled in the spring of 1934. That network was releveled 7 times between Nov. 1934 and Apr. 1940, inclusive, again in 1948 and 1954, and in part in 1956 and 1959, all by the U. S. Coast and Geodetic Survey.

The releveing of the network in 1954 indicated that subsidence of the land surface had reached 7.75 ft. at bench mark P 7 San Jose. Subsidence near Sunnyvale from 1934 to 1954 was greater than at San Jose. The maximum subsidence from 1948 to 1954 occurred at San Jose and was on the order of 2.4 ft. By Dec. 1959, total subsidence at bench mark P 7 since 1912 was 9.04 ft.

The area of land-surface subsidence extends some 25 mi. from Redwood City on the N. to and beyond San Jose on the S., has a maximum width of about 13 mi., and affects at least 230 sq. mi.

Plots of subsidence at individual bench marks compared to fluctuation in artesian pressure indicate that decline in artesian pressure is a major cause of subsidence. The rate of subsidence is generally in accord with the rate of fluctuation of the artesian pressure. Subsidence virtually ceased during a period of increasing artesian pressure from 1937 to 1940, but resumed at an accelerated rate during a period of rapidly decreasing artesian pressure from 1944 to 1950.--Auth.

3-3542. Leeyus, L. A. SILVER FALLS TUNNEL AND SURGE TANK DESIGN: Engineering Jour., v. 44, no. 3, p. 58-67, illus., 7 diags., March 1961, 16 refs.

A concrete-lined pressure tunnel, 10,180 ft. long and 14 ft. 6 in., finished diameter, is a major feature of the Silver Falls hydroelectric development in northwestern Ontario. A single 60,000 h.p. unit operates under a maximum head of 350 ft. A steel surge tank is connected to the tunnel through a shaft, 700 ft. from the power house. Bedrock of the Kaministiquia Valley at the power site consists of massive paragneisses and granites, typical of the Canadian shield, the paragneisses being much folded with major intrusions of gray granite, minor intrusions of pink granite, and much faulting. One stretch with shallow rock cover complicated the necessary design of the reinforced concrete tunnel lining.--R. F. Legget.

3-3543. SOIL AND FOUNDATION ENGINEERING IN THE UNION OF SOVIET SOCIALIST REPUBLICS: Natl. Research Council, Highway Research Board, Spec. Rept. 60 (Natl. Acad. Sci.-Natl. Research Council, Pub. 806) 188 p., illus., diags., graphs, 1960, refs.

The report on the exchange visit of an American delegation of soil and foundation engineers to the U.S.S.R., Sept. 14-Oct. 5, 1959, to study Soviet research, design, construction, and education in the field of soil and foundation engineering. Included in the report are the papers presented by Soviet soil scientists and engineers in the United States during their visit of May 31-June 21, 1959.

Pt. 1 deals with the development of the U.S.A.-U.S.S.R. exchange, itinerary for the delegation, and the seminars.

Pt. 2 concerns the observations and impressions of the delegation. The status of soil engineering in the U.S.S.R. is well advanced in areas of importance to the economic development of the country and includes development of precast foundation units, vibratory driving of piles and hollow caissons, thermal stabilization of loess, and construction on permafrost. However little evidence was seen of extensive studies of shear strength of clays, properties of compacted soils and field compaction problems; work on cement, bitumen, and chemical stabilization has only recently begun. Education in soil engineering at both undergraduate and graduate levels is of high quality, and substantial numbers of competent soil engineers and researchers are being developed. Funds, facilities, and personnel are being provided for long-term research on the performance of actual structures, and the magnitude of the effort expended on large scale experimentation and subsequent evaluation appears to exceed that being done in the United States. The Soviet engineers were well informed of work being done in the United States.

In Pt. 3 the delegations discuss their visits to 4

research or design institutes in Moscow, the Ukrainian Academy of Construction and Architecture in Kiev, the local branch of the Academy of Construction and Architecture in Leningrad, and the City Trust of Geological Engineering and Mapping in Moscow. A review includes reports on research and equipment conducted in many areas of study.

Pt. 4 is a report on education and research at Moscow University, Moscow Civil Engineering Institute, Kiev Polytechnic Institute, and the Leningrad Polytechnic Institute. Soil mechanics is in the Div. of Engineering and Hydrogeology which is part of the Geology Dept. of Moscow University.

Pt. 5 deals with delegation visits to a variety of construction jobs which include highway construction, the Stalingrad hydroelectric station, Volga-Don canal, driving of bearing and sheet piles and caisson shells, and apartment building construction.

Pt. 6 contains the papers presented by the Soviet delegation during their visit to the U.S.A. The list of papers (in English) includes:

- Problems of Frozen Soil Mechanics in Engineering Practice, by N. A. Tsytovich.
- Equipment for Field Geotechnical Investigations of Soils, by I. M. Litvinov.
- Use of the Vibratory Method for Sinking Piles and Pile Shells in Bridge Construction in the U. S. S. R., by Mikhail M. Levkin.
- On the Development of Soil Mechanics, by N. A. Tsytovich.
- Basic Principles of Flexible Pavement Design and Construction, by Vassily M. Bezruk.
- Stabilization of Settling and Weak Clayey Soils by Thermal Treatment, by I. M. Litvinov.
- Foundation Analysis for Machines with Dynamic Loads, by Roman A. Tokar.
- On the Design of Foundations by the Method of Limit State of the Soil Base, by N. A. Tsytovich.

Pt. 7 contains the papers presented by the American exchange delegation and includes:

- Floating Caisson Foundations. Steel Piles with Attachments, by John Lowe, III.
- Current Practices in Soil Sampling, by John Lowe, III.
- Lateral Pressures of Soils, by Gregory P. Tschebotarioff.
- Critical Elements of Design and Construction of Heavy-Duty Flexible Pavements, by Willard J. Turnbull.
- Rotary Cone Penetrometer Investigations, by Willard J. Turnbull, et al.

Five abstracts of other American papers given at Soviet seminars are presented. These papers had previously been published in the United States.--J. Lemish.

3-3544. Tsytovich, N. A. BASES AND FOUNDATIONS ON FROZEN SOIL: Natl. Research Council, Highway Research Board, Spec. Rept. 58, 93 p., 41 figs., 10 tables, 1960, 90 refs.

The Russian original was published by the Academy of Sciences, U.S.S.R., Moscow, in 1958. The translation was made by L. Drashevskaya.

This book is intended for engineering, technical, and scientific workers dealing with the field of construction on frozen soils, as well as for senior civil engineering students at institutions of higher learning. In it are briefly outlined the fundamentals of foundation design for structures erected on frozen soils, and special problems of foundation construction

procedures and of maintenance of structures on frozen soils, as well as technical measures against harmful influences of changes which occur in soils during their freezing and thawing. The book utilizes only books on frozen ground construction published prior to 1947 and separate articles on frozen ground studies printed in recent years.--From ed. note & pref.

Chapters deal with the following topics: general information on frozen soils; physico-mechanical processes in freezing soils; physical and mechanical properties of frozen soils; properties of frozen soils on thawing; methods of construction on frozen soils and engineering preparation of the site; principles of foundation design by method of retaining the frozen condition of base soils; foundation design methods which consider thawing of frozen base soils; principles of foundation design to resist frost-heaving; special features of foundation construction and maintenance of structures erected on frozen soils.

3-3545. National Research Council of Canada, Associate Committee on Soil and Snow Mechanics. PROCEEDINGS OF THE SIXTH MUSKEG RESEARCH CONFERENCE, APRIL 20 AND 21, 1960. Prepared by I. C. MacFarlane and J. Butler: Its: Tech. Memo no. 67, 155 p., illus., diags., graphs, tables, Feb. 1961, refs.

This is a record of the Sixth Annual Muskeg Research Conference which was held at the Palliser Hotel in Calgary, Alberta, on Apr. 20 and 21, 1960. The conference was sponsored by the Associate Committee on Soil and Snow Mechanics, National Research Council of Canada. Topics considered included road construction and transmission line structure foundations on muskeg, classification systems used by different organizations, the role of aerial interpretation, utilization of special vehicles in muskeg, aspects of permafrost as relating to muskeg, logistics, timing and personnel problems in the N. and muskeg in relation to northern development. A list of those in attendance is included as Appendix "A" of these proceedings. In Session 1, under the chairmanship of Dr. R. M. Hardy, 5 papers were presented. Session 2 was chaired by Mr. T. A. Harwood and consisted of a panel discussion as well as 3 papers. Chairman of Session 3 was Mr. I. C. MacFarlane; 2 papers were presented and a short film shown. Four papers were presented during Session 4, chaired by Dr. J. Terasmae. Session 5, a panel discussion under the chairmanship of Mr. R. A. Hemstock, brought the Conference to a close.--Foreword.

The following papers are given:

SESSION 1: HIGHWAY CONSTRUCTION AND FOUNDATIONS

- 1) Construction Experiences in Peat Bogs and Muskeg in British Columbia - R. C. Thurber.
- 2) Muskeg and Permafrost in Highway Development in the Canadian Sub-Arctic - J. P. Walsh.
- 3) The Practical Application of Preconsolidation in Highway Construction over Muskeg - C. O. Brawnner.
- 4) Transmission Line Structure Foundations in Weak Soils - M. Markowsky and N. J. McMurtrie.
- 5) Evaluation of Road Performance over Muskeg in Northern Ontario - Second Stage - I. C. MacFarlane.

SESSION 2: CLASSIFICATION AND EXPLORATION

- 1) Panel Discussion on Classification of Muskeg.
- 2) Operating in Permafrost and Muskeg in the Eagle

Plains Area in the Yukon Territory - W. G. Campbell.

- 3) Guides for the Interpretation of Muskeg and Permafrost Conditions from Aerial Photographs - J. D. Mollard.
- 4) The Procurement of Physical and Mechanical Data for Organic Terrain - K. Ashdown and N. W. Radforth.

SESSION 3: MISCELLANEOUS INVITED PAPERS

- 1) The Successful Use of Tracked Transporters in Shell's Search for Oil in the Muskeg of Northern Canada - D. G. Stoneman.
- 2) Timing, Logistics and Personnel in North Country Operation - B. W. Gillespie.

SESSION 4: PERMAFROST

- 1) Some Aspects of the Permafrost Problem - T. C. Mathews.
- 2) The Engineering Aspects of Permafrost in the Petroleum Industry - R. A. Hemstock.
- 3) Some Aspects of Muskeg in Permafrost Studies - R. F. Legget and J. A. Pihlainen.
- 4) Climate, Archeology and Permafrost - T. A. Harwood.

SESSION 5: NORTHERN DEVELOPMENT

Panel Discussion on Muskeg in Relation to Northern Development.

3-3546. Jumikis, Alfreds R. CONCERNING A MECHANISM FOR SOIL MOISTURE TRANSLOCATION IN THE FILM PHASE UPON FREEZING: Natl. Research Council, Highway Research Board, Proc. v. 39, p. 619-639, 12 figs. incl. illus., graphs, 1960, 36 refs. (not seen at AGI).

This paper reviews the double layer theory and other surface area phenomena which are applicable to processes which occur in a freezing soil system. The electric double-layer theory serves as the theoretical basis for understanding soil moisture translocation in the film phase upon freezing. A hypothesis is presented for the possible mechanism for upward migration of soil moisture in the film phase during freezing. Experiments were based on those assumptions, and observations from soil freezing experiments indicate that induced electrical potentials between 40 and 120 millivolts were measured, and subpressures of soil moisture as high as 32 cm. of Ag were observed. --J. Lemish.

3-3547. U. S. Geological Survey. MILITARY GEOLOGY OF MIYAKO ARCHIPELAGO, RYÜKYŪ-RETŌ. PART I. BASIC ASPECTS. PART II. ENGINEERING ASPECTS. By David B. Doan and others. Prepared under the direction of the Chief of Engineers, U. S. Army, by the Intelligence Division, Office of the Engineer, Headquarters, U. S. Army Pacific, with personnel of the U. S. Geological Survey: 214p., 85 illus., 8 figs., 6 maps (in pocket, each 2 sheets, scale 1:25,000), 17 tables (7 in pocket), [Washington, D. C.], 1960, 23 refs.

Pt. 1 of this report, Basic Aspects, contains information on geology, soils, vegetation, oceanography and bathymetry, physiography, and earthquakes. Pt. 2, Engineering Aspects, evaluates the suitability of rocks and soils for construction and the suitability of the terrain for foundations, roads, airfields, and underground installations. Occurrence, utilization, and conservation of ground-water and surface-water resources are discussed. Pt. 3, Tactical Aspects,

is a separate classified volume not abstracted here.

The Miyako archipelago, a cluster of 6 islands near the southwestern end of the Ryukyu Island chain is between 24°42'-25°0'N. and 125°07'-125°30'E. The largest island, Miyako-jima, is accompanied by the smaller islands of Ogami-jima and Ikema-shima to the N., Irabu-jima and Shimoji-shima to the NW., and Kurema-jima to the SW.

Miyako has a subtropical marine climate, fairly heavy rainfall, uncomfortably high humidity and frequent typhoons. The islands are relatively low and flat in over-all aspect, the maximum elevation being about 350 ft. With one exception, relief of the islands is only locally pronounced; Ogami-jima, however, with an elevation of 250 ft. is noticeably peaked.

The islands are principally great blocks of alternating sandstone and silty shale layers. Each block was warped or faulted upward into relatively shallow water, veneered with layers of coralline limestone, and then partly emerged. The bathymetry of the archipelago shows that most of the mass of each block is inundated and only the summits protrude. Faults control the general shape of each island mass, and many faults transect each island. The oldest rocks exposed in the archipelago are of Miocene age.

The soils in the archipelago well reflect the character of their parent rocks. Soils generally include both clays and loams. In addition to a stony clay containing limestone fragments, several other clays occur widely, each having a characteristic composition and reaction. Sandy, silty clay and clay loams are common, though in general they may be underlain by somewhat clayey soils. Although 1 or 2 soils are fairly acid in reaction, the presence of much limestone has presumably helped reduce the acidity of some other types.

Miyako surmounts a broad, low, structural swell rising from the surrounding sea floor. The upper surface of the old Miyako swell is represented by the angular unconformity between the Miocene (Ogami, Ikema, Gusukube, and Nobaru) formations and the overlying Pliocene and Pleistocene limestones. Following erosion of the uplifted Miocene strata and deposition of superincumbent Pliocene limestone, large-scale normal faulting tilted successive blocks downward to the SW. Fault patterns were controlled by the response to deforming stresses of differing thicknesses of partly indurated Pliocene limestones overlying the less competent Miocene rock strata. Deposition of Pleistocene strata partly covered the tilted blocks as faulting ceased. Slight northward tilting took place in late Pleistocene or early Recent times.

Miyako receives about 90 in. of rainfall per year - a total of about 384,000 acre ft. of water. Although much of this probably is lost by surface runoff and evaporation, a significant quantity percolates downward to accumulate as ground water. Recharge is constant enough that with proper exploitation and conservation large-scale development is feasible. The 80,000 people of the archipelago do not make great inroads upon the total potential water supply.

Natural rock and soil materials consist largely of clays or silty clays and coralline limestone in various stages of induration. A variety of construction materials are available, including rock suitable for aggregate, surfacing, base course, riprap, and masonry. Unconsolidated materials are available for binder, sub-base or subgrade stabilization, and fill. In Miyako-jima, near Hirara, 1 or 2 large quarries have been established in coralline rubble and gravel. These are easily accessible and have large reserves.

Excavation and construction problems range from

minor in the consolidated limestone subgrade to great in some of the unconsolidated materials, particularly the fat clays. Drainage of construction sites is a problem in some terrains, requiring preparation before, and control during, engineer operations. Sub-surface cavernous zones may be scattered in the limestone, particularly along contacts with underlying impermeable clays. In some of the plastic or unconsolidated subgrade materials, steel sheet piling may be necessary for foundation support, confinement of subgrade, or protection of surface excavations from slumping during heavy rains. Potential construction sites for both surface structures and underground installations, however, are available in much of the area. Terrain and subgrade along the E. coast of Miyako-jima is particularly well suited for tunnel-type underground installations. Cut-and-cover underground installations could be constructed in most places. Underground storage of petroleum, oil, and lubricants as well as potable water is feasible in the deep areas of compact gray clay. Road construction is easy in most places but is difficult in areas of plastic clays, rough limestones, or steep scarps. Airfield construction is easiest in W. or SW. Miyako-jima.--M. Russell.

3-3548. U.S. Geological Survey. **MILITARY GEOLOGY OF OKINAWA-JIMA, RYUKYU-RETTO. VOLUME V. GEOLOGY.** By Delos E. Flint and others. Prepared under the direction of the Chief of Engineers, U.S. Army, by the Intelligence Division, Office of the Engineer, Headquarters, U.S. Army Pacific, with personnel of the U.S. Geological Survey: 88p., 26 illus., 11 figs. (incl. 1 map in pocket), geol. map (in pocket, 3 sheets, scale 1:50,000), secs. (in pocket, 1 sheet), 6 tables [Washington, D.C.], 1959, 39 refs.

This report was published in 5 volumes of which this is Vol. V, Geology. Other volumes of the report are as follows: Vol. I. Introduction and Engineering Aspects, by Allen H. Nicol and others, 1957; Vol. II. Water Resources, by Cornelia C. Cameron and others, 1958; Vol. III. Cross-Country Movement, by Anton J. Vessel, 1957; Vol. IV. Soils, by Carl H. Stensland, 1957.

Okinawa and most other islands of the Ryukyus are the exposed crest of a large arcuate submarine ridge extending 1,250 km. from Kyushu, Japan, to Taiwan. On Okinawa, raised late Tertiary and Quaternary reef limestones and associated sediments overlie a thick sequence of tilted Miocene marls and complexly folded and faulted low-grade metamorphic geosynclinal deposits, mostly of late Paleozoic age.

Okinawa is divided into 2 physiographic provinces: 1) a northern province characterized by a high, discontinuous, mountainous backbone ridge flanked by wide dissected terraces; and 2) a southern province having open, rolling to dissected uplands flanked by limestone terraces and coastal flats. Coralline limestone reefs fringe much of Okinawa and all offshore islands.

The sedimentary rocks of Okinawa represent 3 sequences each of which has distinctive rock types formed under relatively uniform depositional conditions. The oldest sequence, represented by the Kunchan group and the Motobu formation, composes the basement of northern Okinawa. The rocks of this sequence are widespread sedimentary deposits with an aggregate thickness of many thousands of meters and were deposited in a geosynclinal trough, probably during late Paleozoic time. The sediments have been complexly deformed, slightly metamorphosed, and

locally intruded by igneous rocks. A second sedimentary sequence includes the Miocene Shimajiri formation, the oldest exposed rocks of southern Okinawa. It is thought to be a thick wedge of sediments which accumulated mostly at considerable distances from then-existing land masses. The latest depositional sequence includes all Pliocene, Pleistocene, and Recent deposits of the island. The reef and bank limestones, gravels, and alluvium are typical of those developed on and around islands in warm seas. The 3 major sequences are here divided into several formations and members having distinctive lithologies that can be recognized and mapped in the field.

The rocks of Okinawa reflect the long-continued structural activity that is characteristic of island arcs bordering the W. side of the Pacific Ocean. The older pre-Tertiary rocks exposed on northern Okinawa have been highly deformed by folding, faulting, and the intrusion of igneous rocks. The late Tertiary and Pleistocene deposits of southern Okinawa and the Pliocene and Pleistocene deposits and extensive terraces of northern Okinawa have been faulted, tilted, and domed by more recent activity. Occasional earthquakes which originate near Okinawa, and the presence of active volcanoes elsewhere in the Ryukyu Islands indicate continuing deformation of the island arc; however, the effects on Okinawa itself have not been great within historic times. The geologic history of Okinawa can be divided into 4 major subdivisions: 1) Paleozoic sedimentation, 2) Mesozoic and early Tertiary deformation and intrusive activity; 3) Miocene sedimentation, and 4) Pliocene to Recent sedimentation and deformation.

Mineral and rock resources which have been prospected and used on Okinawa include clay, limestone for cement and lime, rock and soils for construction, Cu, and Mn. Gas, coal, and phosphate have been reported, but deposits are too small or of too low grade for development.--M. Russell.

3-3549. U.S. Geological Survey. **MILITARY GEOLOGY OF TINIAN, MARIANA ISLANDS.** By David B. Doan and others. Climate, by David I. Blumenstock. Prepared under the direction of the Chief of Engineers, U.S. Army, by the Intelligence Division, Office of the Engineer, Headquarters, U.S. Army Pacific, with personnel of the U.S. Geological Survey: 149p., 16 illus., 10 figs. (3 in pocket), 5 maps (in pocket, scale 1:25,000), 13 tables (5 in pocket), [Washington, D.C.], 1960, 56 refs.

This report comprises 3 principal parts: Pt. 1, Description of Terrain and Environment, presents the fundamental results of geologic and soils mapping plus additional information relating to climate, physiography, geophysical phenomena, generalized oceanography and bathymetry of surrounding waters, and an introduction describing useful or interesting background information relating to the island. Pt. 1 includes 1:25,000-scale maps of the topography and culture, geology, and soils. Pt. 2, Engineering Aspects, presents evaluations of the consolidated and unconsolidated natural materials of the island for use in engineering construction, evaluation of the terrain according to its suitability for construction of foundations and for airfield construction and expansion, and a study of the ground-water resources of the island with recommendations for future development. Pt. 2 includes 1:25,000-scale maps on engineering materials, airfield construction feasibility, and ground-water resources. Pt. 3, Tactical Aspects, is a separate, classified volume, not abstracted here.

Tinian, one of the southern and larger Mariana Islands, is between 14°55' N. - 15°06' N. and 145°35' E. - 145°41' E. The climate is uniformly warm and humid. Trade winds are dominant throughout the year. July through Oct. is the rainy season, with about 45 in. of rain in the average year. During the distinct dry season, Feb. through Apr. rainfall averages less than 10 in. The annual average is about 10 in.

Tinian is roughly rhombic in shape, is 12.5 mi. long from N. to S. and about 6 mi. wide from E. to W., and has a total area of about 40 sq. mi. The greatest relief is formed by 2 relatively prominent blocks, one in the N.-central part and one at the S. end of the island. The shoreline is formed predominantly by sea cliffs 20 to 100 ft. high, although some cliffs reach nearly 500 ft.

The total surface of the island comprises 5 physiographic units: the northern lowland, the north-central highland, the central plateau, the median valley, and the southeastern ridge. These well defined divisions are useful in describing the geologic structure.

Tinian is composed essentially of great masses of volcanic tuffs and breccias that are saddled and fringed with layers of progressively younger coral-lime limestones, building upward and outward from the volcanic foundation and core. At times during the history of the island large faults have transected its mass and have moved separate blocks in different directions relative to one another. Moreover, sea level has risen and fallen with an amplitude of hundreds of feet relative to the island. The island is the complex result of block movement, marine sedimentation, and reef growth at various altitudes on the various blocks.

With the exception of thick red plastic clay soils on the weathering exposures of volcanic rocks, the soils are generally fairly shallow and include red to brown clays, stony clays, clay loams, and some foamy sands. In general the thicker, more red, and more clayey soils are on the older limestone surfaces. Limestone pinnacles 1 to 3 ft. high protrude through the soils in many parts of the island.

Drainage throughout most of Tinian is internal; the water percolates straight downward into porous rock. Consequently, there are no streams and no particular drainage problems. After the assault and capture of Tinian in 1944 by forces of the United States, about 40 producing water wells were drilled. Ground water is plentiful in a basal ground-water lens.

Rock suitable for concrete aggregate, surfacing, base course, riprap, masonry, and fill are available in large quantities. Plastic material suitable for binder occurs in several places. Excavation and construction problems generally are not serious. Drilling and blasting are required for working in some parts of the island. Drainage is very good in most places and with ordinary precautions is only a minor consideration in excavation and construction. Sub-surface caverns probably occur along some fault zones, which must be avoided until test drilling proves the subgrade adequate for the bearing pressures required. Mass slumping in a few places, generally adjacent to steep scarps, may preclude construction at otherwise ideal sites.

Expansion of the 2 existing major airfields is feasible. Foundation conditions, excavation characteristics, drainage, construction material availability and accessibility, and topographic conditions or restrictions for expansion of present airfields as well as for each of 5 potential sites are considered.

The water resources of Tinian Island are extensive and capable of fairly easy exploitation. Fresh

water in a basal ground-water system occurs according to the Ghyben-Herzberg principle. Drilled wells and Maui, or infiltration, wells have been successful. The past peak production of about 2.3 million gallons per day probably can be exceeded if a program of careful exploration and testing is devised.--M. Russell.

3-3550. U.S. Geological Survey. MILITARY GEOLOGY OF YAP ISLANDS, CAROLINE ISLANDS. PART I. GENERAL DESCRIPTION OF TERRAIN AND ENVIRONMENT. PART II. ENGINEERING ASPECTS OF THE TERRAIN. By Charles G. Johnson and others. Weather and Climate, by David I. Blumenstock. Prepared under the direction of the Chief of Engineers, U.S. Army, by the Intelligence Division, Office of the Engineer, Headquarters, U.S. Army Pacific, with personnel of the U.S. Geological Survey: 164p., 64 illus., 10 figs., 5 maps (in pocket, scale 1:25,000), 20 tables (7 in pocket), [Washington, D.C.], 1960, 36 refs.

The report is in 3 parts: Pt. 1, General Description of Terrain and Environment; Pt. 2, Engineering Aspects of the Terrain; and Pt. 3, Tactical Aspects of the Terrain. Basic data and general information to provide background are in Pt. 1, and interpretive data are in Pts. 2 and 3. Pt. 1 also contains basic data relative to physical properties of rocks and observations and data on water supply and mineral deposits. Pt. 3 is a separate, classified volume, not abstracted here.

The Yap group of islands is in the western part of the Caroline Islands at 9°30' N. and 138°07' 5"E., 450 nautical mi. SW. of Apra Harbor, Guam. The group comprises the individual islands of Yap, Gagil-Tomil, Map, and Rumung, as well as several islets.

The islands of Yap are continually immersed in air that flows from the tropical oceans, bringing with it incessant warmth, high humidities, dense to scattered clouds, and abundant rain. Temperatures are remarkably uniform, averaging 82°F. in the summer months and 80°F. in the "cool season." The average cloud cover is 74%, the average rainfall, 119 in.

High hills make up the northern half of Yap Island. They dominate a low, partly dissected plateau to the E. which is 1 to 3 mi. wide, with an average altitude of about 30 to 40 m. Map and Rumung, N. of the plateau, are uniformly dissected into rounded, moderately steep hills. The shorelines of the islands of Yap, Gagil-Tomil, and Map are very irregular with deep reentrants. All coastal flats are narrow, long, and discontinuous. Most streams are small perennial creeks.

Streams and rain catchment are the chief sources of water supply. The supply cannot be appreciably augmented by well development. The water resources of the islands are small, and they decrease sharply during the months of Feb., March, and Apr., when rainfall is at a minimum.

The Yap islands are near the southern end of a submarine ridge known as the W. Caroline geanticline. The ridge is about 850 mi. long; it trends east-northeasterly from near Palau, and northward beyond Yap its trend is nearly true N. The E. side of the ridge in the vicinity of Yap slopes steeply into the W. Caroline trench, which near Yap is as much as 4,122 fathoms deep; the W. side slopes gently into the Philippine basin to an average depth of about 2,500 fathoms.

Relationships between the major rock map units are clearly visible in the field. The basement rocks (the Yap formation) are dominantly schists, phyllites, and massive rocks of the greenschist and amphibolite

metamorphic facies intruded by ultramafic masses, dikes, and sills, which are for the most part serpentinized. These metamorphic rocks make up most of the western and northern parts of the group of islands, and the ultramafic intrusive rocks are exposed at small discontinuous outcrops in the central and eastern parts. Overlying the basement rocks in the northeastern part is a mass of breccia, the Map formation - partly tectonic and partly sedimentary - which is composed of a great variety of rock types, mainly greenschist, hornblende, and serpentine. The upper part of the breccia is sedimentary and ranges in texture from cobble and boulder-size to fine gravel-size fragments in a fine matrix. Locally, in channel fillings, are fine to coarse, green, well stratified sandstone and siltstone containing large foraminifers of Miocene age (Tertiary f_1). The Tomil volcanics, composed of andesitic tuffs, volcanic breccias, and lava flows, all almost completely weathered to clay, unconformably overlie the breccia and basement rocks in the central part and the southernmost tip of the Yap islands. Surficial deposits of limonite concretions and ferruginous clay are scattered over both the basement and the volcanic rocks, and where concentrations are great enough, the limonite is Fe ore. Alluvial deposits of clay, silt, sand, and gravel occupy valley bottoms, beaches, and mangrove swamps. Surrounding the entire island group is a fringing coral reef. Well out on the reef off the SE. coast is a small island of raised reef limestone (the Garim limestone). This island and 2 tiny mushroom rocks on the reef flat off the southern tip of Yap Island are the only raised reef

limestone of the island group. The limestone is considered to be Pleistocene to Recent in age.

The geologic structure is a complex of intricate folds, thrust faults, a graben or tilted fault blocks, and minor normal faults.

The chief mineral resource of the Yap islands is a relatively small quantity of nickeliferous-Fe laterite. The best deposit, at Gatjapar, is estimated to contain 1,415,000 short tons, averaging 0.74% Ni and 41.7% Fe. Cu deposits on Yap also are of commercial grade, but prospects for their future development are highly speculative. Au is found sparingly in quartz veinlets and small quartz masses. Asbestos is common throughout the serpentine areas, but is economically unimportant. Low-grade Mn ore and bauxite also occurs sparingly.

Four major groups of soil are present: latosols; planosols; lithosols; and soils of coastal flats, valley bottoms, and inland depressions. They generally have poor to fair characteristics for engineering use. Yap is short of first-rate engineer construction materials. There is essentially no stream gravel; an extremely small quantity of dense limestone is available but is nearly inaccessible; fresh, hard rock such as traprock is not available. Greenschist containing lenses of hard rock, breccia containing hard rock fragments in a fine-grained matrix, and coral limestone of the coral reef are the chief rock types; silty and clayey sands, sandy silts and clayey silts, and fat clays are the chief soil types.

Yap is in general not suited for the construction of large installations, but is suited for construction of small installations.-M. Russell.

15. MISCELLANEOUS

3-3551. Leet, L. Don, and Florence J. Leet, eds. **THE WORLD OF GEOLOGY: 262 p., illus., maps, tables**, New York, McGraw-Hill, 1961.

This book is a compilation of 19 selections and adaptations from the previously published works of such writers as Reginald Daly, Edwin H. Colbert, Rachel L. Carson, and Marland P. Billings assembled and introduced by L. Don Leet and Florence J. Leet to tell the story of geology in the words of recognized writers in each field. It is a book aimed apparently at the well-informed, scientifically inclined layman and designed to arouse his interest in the significance and potential of the entire spectrum of geology.

The papers included are as follows:

Geology, 1900-1950, by Reginald A. Daly.

The Origin of the Earth, by Fred L. Whipple.

Records of Life, by Percy E. Raymond.

The Development of Life, by George Gaylord Simpson.

Man and Geologic Time, by Edwin H. Colbert.

The Origin of the Atmosphere, by Helmut E. Landsberg.

Oceans and Their Hidden Lands, by Rachel L. Carson.

The Ocean's Deep, by Don Walsh.

A Giant of Geology: Agassiz, by Carroll Lane Fenton and Mildred Adams Fenton.

Ice on the Land, by Louis Agassiz.

Ice and Ocean Levels, by Rachel L. Carson.

Giant Waves, by Joseph Bernstein.

The Restless Earth and its Interior, by L. Don Leet.

A Volcano Erupts, by Jerry P. Eaton and Donald H. Richter.

Volcanoes Build the Land, by Howel Williams.

Wearing Away of the Land, by S. J. Shand.

Water Under the Ground, by Robert M. Garrels.

Materials of the Earth, by Carroll Lane Fenton, and others.

Mountain Story, by Marland P. Billings and Charles R. Williams.

3-3552. Lahee, Frederic Henry. **FIELD GEOLOGY: 6th ed., 926 p., 641 figs., 15 tables**, New York, McGraw-Hill, 1961, approx. 300 refs.

This book treats the subject of geology from the field standpoint. It is intended both for a textbook and for a pocket manual. As a manual it should be of service not only to students of geology, but also to mining engineers, civil engineers, and others whose interests bring them in touch with geologic problems. The book has been written on the assumption that the reader has an elementary knowledge of general geology and also an acquaintance with a few common minerals and rocks.

The first 12 chapters are concerned with the recognition and interpretation of geologic structures and topographic forms as they are observed. Here the aim has been to describe together phenomena which in certain respects resemble one another, but which may be of diverse origins. Where possible the treatment has been empirical rather than genetic. In order to assist the reader in identifying various forms and structures, a number of tables or keys have been prepared.

In the last 6 chapters are described methods of geologic surveying, the nature and construction of maps, sections, and block diagrams, the interpretation of topographic and geologic maps, the solution of certain geologic computations, and the preparation of

geologic reports.

An appendix containing several tables of practical value, a bibliography to which there are many footnote references throughout the text, and an index which has been made as comprehensive as possible, will be found at the end of the book.

In preparing the sixth edition of *Field Geology*, the plan of treatment maintained since the first edition in 1916 has been followed as closely as possible. Many new terms have been concisely defined and explained such as turbidity currents, stone tracks, patterned ground, soil profile, biologic facies, palynology, pluton, lopolith, phacolith, ringdike, cone sheet, metamorphic facies, boudin, diapir fold, wrench fault, granitization, and so on. New text has been added on contemporaneity in sedimentation, on tectonic correlation of sediments, on the "granite problem," on the terms "base level" and "grade," on the use of the Jacob staff, on distortion and displacement in air photographs, on the use of air and gas in drilling deep holes, on induction logging, on sonic (continuous velocity) logging, on dipmeter surveying, on presently used methods of electronic surveying, on refraction seismic shooting for overhang of salt domes, and so on. In view of the almost complete substitution of the gravimeter for the torsion balance in gravity surveying, this section of the chapter on geophysics has been completely rewritten.

The bibliography contains 65 new up-to-date references. Since the older references have a historical value they have not been removed. Two of the earlier figures have been revised and 16 new figures have been added.--From pref. to 1st & 6th eds.

3-3553. Defant, Albert. *PHYSICAL OCEANOGRAPHY*: 2 v., 579 figs., 4 charts (in pocket), 8 pls. (in pocket), 253 tables, New York, Pergamon Press, 1961, approx. 1000 refs.

Physical Oceanography consists of 2 volumes, each having 2 sub-parts. The first part of Vol. 1 deals with the spatial, material, and energetical characteristics of the water envelope of the earth, as well as with the evaporation problem and the ice in the sea. For this reason it specially involves the physical and chemical properties of sea-water, the spatial distributions of the oceanographic elements in the total oceanic space and its periodic as well as aperiodic changes. The second part of Vol. 1 concerns the various modes of motion of sea water in the form of ocean-currents (dynamic oceanography). Finally, Vol. 2 is devoted to periodic movements of the water masses (waves, tides, and related phenomena). The individual problems of physical oceanography are discussed in as much detail and supported as far as possible by appropriate examples and references to existing compilations of observational data. The scientific progress of the last decades has been considered almost completely, not only with regard to the observational facts, but also concerning the theoretical treatment and explanation of the observed phenomena. The oceanographic literature has been considered in its entirety to the end of May 1957. Extensive reference lists are provided at the end of each sub-chapter concerning the literature sources used and can be considered as unique in their completeness.

A presentation of instruments and apparatus in use in oceanographic research, their technical function and instrumental theory, was not intended to be included in the textbook.--From auth. pref.

3-3554. Lomský, Josef. *SOUPIŠ PERIODIK GEOLOGICKÝCH VĚD: PERIODICA GEOLOGICA, PALE-*

ONTOLOGICA ET MINERALOGICA [List of Periodicals of Geological Sciences: Geological, Paleontological and Mineralogical Periodicals]: 499 p., Prague, Czechoslovakia, Nakladatelství Československé Akademie Věd, 1959.

An alphabetical compilation of 3,582 periodical titles in geology and allied sciences, covering the period from the beginning of the 18th century to 1958. The periodicals are described in their original languages, noting title, subtitle (if any), editing organization, place and dates; also changes of titles and any possible relations to other periodicals. Subject indexes are included.--A. C. Sangree.

3-3555. Canada Dept. of Mines and Technical Surveys, Geographical Branch. *SELECTED BIBLIOGRAPHY OF CANADIAN GEOGRAPHY WITH IMPRINT 1959*: Its: Bibliog. Ser. no. 27, 75 p., 1961.

The Geographical Branch is responsible for preparing an annual bibliography of books, pamphlets, and periodical literature relating to Canadian geography, for submission to the *Bibliographie Géographique Internationale*. The Branch also prepares an annual bibliography of maps published in Canada for submission to the *Bibliographie Cartographique Internationale*. Both these bibliographies are published in France under the auspices of the International Geographical Union with the concurrence of UNESCO and the French National Centre for Scientific Research.

The present volume was prepared by the Reference Services Division of the Geographical Branch and includes both the bibliography of books and the bibliography of Canadian maps.--N. L. Nicholson.

In Pt. 1, Books and Periodicals, references are classified by subject under Canada as a whole, then by regions under Eastern Canada and Western Canada. Theses and dissertations are listed separately. In Pt. 2, Maps, references are listed under large regions and the various provinces. Topographic, aeromagnetic, and aeronautical series are listed; also hydrographic charts.

3-3556. *REPORT OF THE UNIVERSITY COMMITTEE ON POLAR RESEARCH*: 46 p., tables, Ann Arbor, Michigan, Feb. 1961.

In recognition of the importance of institutions of higher learning in polar research, Dr. Laurence M. Gould, President of Carleton College, and chairman of the Committee on Polar Research of the National Academy of Sciences, appointed a 9-man committee to investigate the way in which American colleges and universities could most effectively engage in polar research. The membership was later increased by 5 members to provide for more complete coverage of fields of interest.

The University Committee on Polar Research met for the first time in Washington, D. C. on May 5, 1959. At its second meeting on Sept. 20-22, 1959, at Shenandoah National Park, the committee decided to gather information by sending questionnaires to colleges and universities in the United States known to have interest in polar studies.

The committee met in Ann Arbor on March 21-22, 1960, to review the analyses of the questionnaire data. Preliminary recommendations were formulated during the concluding sessions of this meeting. The committee was convened Oct. 17-19, 1960, in Ann Arbor, to prepare abstracts of the survey results by fields, to formulate final recommendations, and to

complete the manuscript for this report.

Ten different subject-area categories were surveyed with respect to polar research: 1) geophysics of the solid earth; 2) physics of the upper atmosphere; 3) meteorology and climatology; 4) oceanography; 5) geology; 6) glaciology; 7) soil science; 8) biological sciences; 9) health sciences; 10) anthropology-archeology. Summaries are given of the results of the questionnaire in each of these fields, and recommendations are made. Appendices give the questionnaire and comments on the summary report of the Dartmouth conference of Dec. 18-19, 1958.--From p. 8-10.

3-3557. Eventov, Ya. S. QUESTION OF THE METHOD OF GENERAL GEOLOGIC STUDY OF COVERED REGIONS WITH THE NORTH AND NORTH-WEST PRI-CASPIAN AS AN EXAMPLE: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 4-B, p. 239-248, 4 maps, profiles, 1959, pub. 1961, 12 refs.

Based on experience gained in the N. and NW. Pri-Caspian area it is suggested that the geological study of a region entirely covered by Pliocene and Quaternary sediments should be done in successive stages. After mapping the surface exposures with the aid of an aerogeologic survey, a gravimetric survey must be carried out. This is to be followed by seismic work and the drilling of a small number of wells necessary for the correct interpretation of the geophysical data. The study should finally result in the compilation of geological-seismological profiles and of geological maps of the underground with the Quaternary and Pliocene stripped off. Also maps should be prepared giving isopachs of the Quaternary and Pliocene, or contour lines drawn on the base of these covering formations. The region mentioned as an example measures about 270,000 km.² of steppe area with practically no outcrops and a Pliocene-Quaternary

cover which in places reaches a thickness of over 600 m. Its northern part forms a continuation of the salt dome territory of the Emba oil district, but structures are different in the S. where a regional gravity maximum occurs.--C. Voûte.

3-3558. American Geological Institute. FILMS FOR EARTH SCIENCE COURSES: Its: *Geology Ref. Ser. for Sci. Teachers* S-3, 5 p., July 1961.

A selected list of 86 films relating to astronomy, geology, geophysics, meteorology, and oceanography compiled by the Visual Education Committee of the American Geological Institute as an aid to earth science teachers. Information given for each film includes: title, film width, black and white or color, sound, running time, date, name and address of distributor, annotation. A more comprehensive directory is planned for 1962.--A. C. Sangree.

3-3559. Mironov, S.I. I. M. GUBKIN - AN EXAMPLE OF THE CLOSE ASSOCIATION OF THE SCIENTIFIC CREATIVE WITH THE PRACTICAL: *Geologiya Nefti - Petroleum Geology*, in translation, v. 3, no. 4-A, p. 209-214, 1959, pub. 1961.

A biography is given of I. M. Gubkin, who, after having been a teacher, graduated in geology in later life. His main scientific and practical contributions in the field of petroleum geology are briefly mentioned. They concern the finding of productive channel deposits in the Maykop region, of diapir folds in the Apsheron peninsula and of the great oil potential of the Ural-Volga area. Furthermore, Gubkin played an important part in the organization of geological research both before and after the revolution.--C. Voûte.

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